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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

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The Relation Between Farm Building Overhead and Cost of Production*

By John Swenehart[1]

THE attention of agricultural engineers, animal production men, economists, and manufacturers should be directed very definitely to the farm building situation as one of the most important problems in the entire field of agriculture. To draw such attention, I will to a large degree resort to destructive criticism.

Inherited building design, accepted from the past mostly without question, is proving ill-adapted to modern conditions. Industry in its advance has been required to meet housing problems. Agriculture persists with hereditary design in its housing. Agriculture has been outdistanced by industry here as in other ways.

At the outset, I wish to say that no arraignment of any group, particularly of the barn equipment and material manufacturers, is even thought of. I believe the motives of the men comprising these groups are sincere. That they should follow as they have the designs which have grown out of necessity in the immediate past is to be expected. This, however, should not blind our eyes to a problem in need of organized research. The leaders among these manufacturing groups are ready to join in a sound program which I believe can be presented. Neither are my remarks directed at men doing farm building work. I look ahead, not backward.

To establish a basis for understanding in this discussion I am assuming several things:

1. Separate consideration needs to be given to the farm productive plant. Why need we hark back to before the industrial revolution? This paper will be concerned with the farm productive plant. Farm home problems are not necessarily depreciated but they are essentially different
2. The existence of the "big red barn" does not prove its usefulness or justify the design
3. Unless alleged savings in labor and feeding conditions are worth more than they cost, they are unjustified
4. As farm buildings constitute the present large part of production costs, they represent a correspondingly large problem in economic production
5. There is little prospect of dairy production per cow increasing to any considerable extent

I will now show something about building costs based on several kinds of data which seem to check each other very close.

First, immediate farm problems involving remodeling and rebuilding. For example, a few weeks ago I had a call from a man, with land which he considers worth $6,000, who wanted a plan for a barn which would cost roughly $6,000 and house twenty producing cows of ordinary grade. This would mean on a basis of the $6,000 cost estimate, which he had secured from local contractors, an investment of $300 per cow. I asked him whether his ordinary cows were good enough to justify this expense, which would amount to at least $30 per year as a fixed overhead charge out of a probable production amounting to about $120 per year.

Note also in this connection that he could only borrow, using his farm plus the physical value of the barn after it was erected, about $4200 or 50 per cent of the value of the land which amounts to $3,000 plus 20 per cent of the value of the barn amounting to $1200. Obviously, in order to get sufficient finance for this loan, he would have to pay a high rate of interest and still further decrease the possibility of success.

The second source of data bearing on this question is found in available statistics on Wisconsin including state departments and census figures (other states check.) Wisconsin has only about one-tenth of the nation's dairy industry.

In Wisconsin farm buildings, according to the census, are valued as follows:

Total	$688,000,000
Dairy buildings	400,000,000
Actual value of dairy buildings exceeds 2,000,000 cows at $250 per cow	500,000,000
Gross dairy income is	225,000,000
Value of machinery and equipment (for comparison)	146,000,000

Overhead charges which must be accounted for on the above valuations are interest, taxes, insurance, and maintenance. These will amount to 10 to 14 per cent of 500 million dollars, or 50 to 70 million dollars.

We thus have a total of upwards of 50 to 70 million dollars annual fixed overhead out of a 225 million dollar gross income. This is two and one-half months' production of all Wisconsin cows, or 10 to 12 cents per pound of butter fat. This overhead must be paid before feed, cost of the herd, labor and profit. If we allow for feed, herd cost and profit, the labor saved cannot be enough to justify the overhead.

To date we have passed the problem off by saying we have our barns. It is true, but what about sanitation, not only in whole milk production but for cheese and butter? Cheese and butter or milk production under many of our old barn conditions is being marketed as a cull product. Regulations are becoming more stringent.

Also what about upkeep? How long will a roof last? Farm buildings in general have not been painted. Should they be? We are not putting in a large item for maintenance. Rebuilding funds are not customary. Adequate insurance is not general.

Let us check these figures in still a third way. What is the replacement cost or what will it cost to build now? Last summer we studied a large number of new barns on which we could get the cost. These barns are all on a so-called "dirt" basis. We found that the cost per stanchion in these barns average $289.84, including horse and feed storage where it was connected with the barn, but not including milk house or granary. In practice, under ordinary dairy conditions there is seldom more than three-fourths of the stanchion capacity of the barn actually represented by cows in production, but even on the basis of full use with 10 or 12 per cent overhead our cost per cow runs from $30 to $35 per head, which again represents one-fourth of the annual production and therefore checks closely with the figures arrived at under the previous observations.

It is probably worth while to comment on a fourth consideration. That is, why do loan agencies, even the farmers' own federal land bank, loan on a basis of 20 per cent of the insurable physical value of farm buildings while in Madison, a city of some 50,000 population, a new theater is being financed by a loan of $475,000 on a valuation of $807,000 by an issue of 6 per cent first mortgage bonds? This is 60 per

*Paper presented at the 21st annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June, 1927. Contributed by the Structures Division.

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The question is raised by Prof. Swenehart as to whether the present so-called "modern" two-story dairy barns are worth their cost, measured in terms of economical production, improvement of working conditions, or in aesthetic value to the farmstead. Is a reduction of one-fourth in unproductive overhead possible? These are problems with which agricultural engineers concerned with the design and operation of these structures are confronted

cent of the physical value, but what about the value as a producer of income? Does the difference between 60 per cent, or let us say roughly 50 per cent, of the value as compared with 20 per cent of the value in the case of farm buildings represent the difference in efficiency between farm buildings and industrial and business buildings? In other words, this brings us back to the relation which the cost overhead of buildings should bear to production.

The question may well be asked, to use current slang, "How do we get that way?" Two conditions are largely responsible. First, in most of the livestock producing sections of the country, with the exception of the open range, timber for buildings was available on our farms and was salvaged often as a part of land development operations. The cost of this timber amounted to very little more than hewing or sawing charges, often paid in terms of extra logs otherwise unmarketable. We hauled the logs and built largely ith salvaged labor at little or no cost. It will be remembered that in the period from 1880 to 1910 the price paid for labor was relatively small, averaging about one-fifth to one-tenth of the present cost of the same class of labor. Naturally under such conditions pretentious structures might be expected.

A little later, with the development of more intensive diarying, a gradual change took place. Many of the original timber-frame structures did not meet the new requirements, and when the roof was first replaced the framing was remodeled and strengthened. Forests were used up. The lumber supply is now far away and still diminishing.

Then came the development of dairying to the point where barn equipment became an important factor. As long as these improvements were made at low cost they were not oppressive. At the same time dairy production and livestock production in general was gradually becoming more efficient.

Beginning along about 1900, however, prices of material and labor began very slowly and gradually to climb. Extension of better dairy methods began on a larger scale in the various states. In spite of the attention given to better dairy production, the per cow production has by no means increased in proportion to the cost of overhead and more particularly this increase in efficiency in livestock production has failed to keep pace with the advance of industry as a whole.

A third reason for this condition is that agriculture never made a financial statement to find out where it stood.

At the same time in a couple of generations of use, during which, in a large measure, barns have passed from one family to its descendants, we have developed a sentimental value which must not be overlooked. The big red barn, two stories high with all the "trimmings," has come to be a sign of prosperity. It is important to know that red paint in many sections is a decided factor in this sentimental value, not that anyone would argue for a large, clumsy, red structure as a thing of beauty, particularly as usually landscaped with straw pile, manure spreader, manure piles and miscellaneous fences, etc. At a distance this red structure seems to have a sentimental value but it pays neither interest nor principal on a loan and does not seem to contribute greatly to production, and probably it is fogging many men's eyes as to its advantages.

This pretty well indicates the present status physically, economically and sentimentally of dairy buildings. To a lesser degree the same general principle obtains with respect to housing for other livestock and also accessory buildings. Farm building engineers are slowly getting away from the old monitor type hog and poultry houses, particularly in the northern climates, and a bulletin from as far south as Missouri says that the extra windows in the monitor type house makes the house cold when it is cold and hot when it is hot. In other words, apparently the monitor type hog house and poultry house is passing. There is, however, no considerable degree of unanimity as to design of poultry and hog houses even between states having almost identical climatic, market and productive conditions.

I believe I have substantiated the statement that the present so-called "modern" two-story dairy barns are not worth their cost measured in terms of economical production, improvement of working conditions or in aesthetic value to the farmstead. I believe that dairying is working under a design which, while being called "modern," should be considered hereditary. What part of dairy returns may be charged to building overhead? A reduction of one-fourth in unproductive overhead is, I believe, possible by knowledge available at present.

Hay storage methods involving the entire process from field to cow are costly, and not adapted to the requirements either of climate or of labor saving.

For a manufacturing plant, the dairy barn according to so-called modern plans has too many fancy frills which contribute in no way towards income and yet add much to the physical value and overhead cost. For example, conditions have developed to a point where farmers are putting six, seven and eight hundred dollars into a silo on an ordinary farm. This means 50 cents to $1 per ton of silage.

I believe as a business proposition that the painting of farm plant buildings as now generally practiced is not worth its cost for maintenance. In terms of sanitation, in terms of marketing efficiency the value of outside surface paint is so small as to be nearly negligible. What improvements in materials and methods of application will justify painting? Are farmers right in their tendency to neglect painting the past few years? Why not use wood protection at points of weakness? Is the pride or morale of the farmer affected by red barn paint?

Are production records available to show the value of

fresh air in livestock production such as may be provided by an ordinary system of ventilation? What is ventilation? Will production records show that such an investment will pay its overhead cost? We all admit that properly designed a barn can be ventilated. Does ventilation mean moisture control, heat control or fresh air control? May an expenditure for ventilation be worth much as a maintenance feature on wooden structures?

Will farm machinery housed as is now usually recommended last enough longer to give sufficiently better service to pay the extra overhead cost? Personally I question whether money borrowed for this purpose can be repaid out of the savings it will effect. Who knows?

So far I have been destructive in my criticism. Possibly one or two constructive suggestions can be made. The most constructive suggestion, however, is that farm buildings men take the responsibility for research along these lines, particularly associating this research with animal production on the one hand and agricultural economics on the other. It is admittedly easy to construct a building that will be strong enough, that will meet space requirements, that will have a given number of windows and can be covered with a certain kind of paint. It can have all sorts of details worked out from an engineering standpoint, but if these details do not contribute to the increased production of a cow or other animal housed, or if they fail to meet the economic requiremens, that is, production per unit of cost, it may be a failure. It is patent that industry generally could not stand the present overhead which is being carried by agriculture. Therefore, let us ask for research.

Another suggestion is the adoption of simpler structures, possibly one story in height, simple in framing and low in lumber and labor cost and giving the same if not even greater convenience than the present design.

A third suggestion would be to correlate our efforts with the efforts of the sanitary and health agencies. Some of the requirements of the Chicago milk ordinance are impossible. There is need for a greater correlation between boards of health and buildings men.

In maintenance or rebuilding, which is a very important problem, there is need for conservation of space. High ceilings, forty-foot width barns, big useless pens, obstructing posts and girders can be changed in remodeling to fit a design more economical.

Looking to better hay storage handling methods, we may well cooperate with the farm machinery group. Perhaps in many cases it is not necessary to store all the hay or straw at the farmstead. May it not be possible to conserve high-priced summer labor and store hay near its point of production and during the period of low labor cost bring it to the point of consumption? Haying weather is about the most important detail on the farm for about two months. May we not expect an entire new process in hay handling with a large reduction in space needed?

May there not be some point in the question of separate barns for housing and for milking? May we not develop a milking barn highly efficient, clean, sanitary, labor saving and at the same time house the animals loose, occupying perhaps not over two-thirds the space required under the present system, and get good conditions for heat and moisture control and air movement.

I am convinced that insulation should play an important part in livestock housing structures. Why feed the farmers with air space "bunk"? Insulation may be the first step in real ventilation.

In Wisconsin we have started research in a rather small way and expect to put on a special man next year under Purnell research funds to follow up the economic production and engineering aspects of this problem. We hope to correlate our work with that of other states along the same line. At the same time we hope to work out details of design which may contribute towards a solution of particularly physical problems.

I believe I have touched a few of the bigger problems. I believe these problems are a challenge to us as agricultural engineers. I feel the need for men to study them. We need graduate students. We need cooperation in this research with industry so that research results can be put into practice sooner. I believe that all groups in the American Society of Agricultural Engineers are ready to cast off tradition, ever the foe of efficiency.

Carbon Fixation By Plants*

APPROXIMATELY 1,750,000,000 human beings are eating 2,000 kg.-cal. of food per day. In a year this energy amounts to about $12x10^{14}$ kg.-cal. We might guess that all other vertebrates, the invertebrates, and the soil micro-organisms are consuming about six times this amount. Total yearly consumption would then be $84x10^{14}$ kg.-cal. All of this energy was fixed from sunlight by green plants, by one of nature's most inefficient processes, photosynthesis (combining substances by means of light).

Since only about one per cent of all solar energy falling on green plants is utilized, we might think that we have parcelled out energy too liberally; a few calculations on the income side are of interest. The earth has a land area of 55 million square miles, of which probably half has a crop of plants growing upon it 6 months each year. Assuming that 500 gram-calories of solar energy per square centimeter are received on the land area each day during 6 months and that one per cent is fixed, we calculate that $64x10^{16}$ kg.-cal. are fixed in a growing season. This is about 76 times $84x10^{14}$, the energy value arrived at from the estimated total consumed, and indicates that our first guess was extremely conservative. The quantity $64x10^{16}$ kg.-cal. is equivalent to the energy in about $89x10^{11}$ tons of anthracite, or about 8,900 times the annual world production of coal. The human race consumes annually less than two-tenths of one per cent of this value.

One of nature's most fundamental processes is only one per cent efficient. An unusual opportunity for an efficiency expert. If only a few tenths of any per cent could be added to the efficiency of photosynthesis, an enormous increase would be available in total energy fixed when applied to nature's vast quantity production.

About fifty years ago Siemens found that in winter when light intensity is low, addition of light from an arc lamp gives a noticeable increase in the growth of many plants. Photosynthesis increases with temperature and with carbon dioxide supply within limits. It also increases with light intensity and day length up to a certain maximum. If a plant is given all the light energy it can use for fixing carbon and all the carbon dioxide it can fix, along with a favorably high temperature, what rate of photosynthesis can be maintained? Can we produce wheat, lettuce or tomatoes in a week or a month under these ideal conditions?

Equipment has been collected at the Boyce Thompson Institute for Plant Research, Inc., for answering some of these questions. Several kinds of plants have been grown both with artificial light entirely and with different combinations of daylight supplemented at night with artificial light.

Many plants could be grown from seed to maturity in a remarkably short time. Spring wheat was grown from seed to head in the brief time of 35 days; it needs no rest and will maintain photosynthesis at a high rate, 24 hr. per day, during its life. The tomato under similar conditions will die out completely in about 2 weeks. It is not able to maintain photosynthesis near its maximum rate. Twelve hours of daylight with 6 hours of artificial light, making an 18-hr. day, is all the tomato can withstand. Lettuce will produce a large head in about 3 weeks on an 18-hr. day. After this it will send up a seed stalk. If kept on 12 hr. or less, it does not produce a seed stalk.

During the growth period of these plants 1500 kw.-hr. of electrical energy were used each day, not with the hope that some practical application might be found in growing plants commercially, but for the purpose of learning the effects of environmental factors on photosynthesis. From researches like these may come in time new means for producing some foods and fuels and other supplies for human needs. Economic achievement, however, yet appears remote except in small scales operations.

An Agricultural Engineer in South America

By Stanley F. Morse[1]

THE consulting agricultural engineer never knows where he may be called next. From the polar limits of crop growth to the tropical conditions of the equatorial region is his field of action, and within this territory the lands to be studied may be located at from below sea level to ten thousand or fifteen thousand feet in elevation. That is why, when I was asked to go to South America for the second time during the current year, I set forth without knowing exactly what conditions would be encountered.

A novel problem was presented. It was proposed to build a toll road over the Andes to the coast to connect the Valley of the Cauca and the city of Cali, in Colombia, with the port of Buenaventura on the Pacific. To finance the construction of this road a bond issue of some two millions was sought, and the bankers before making the loan wished to be sure that such a road would be a paying enterprise. Either a toll road or a railroad to pay must have adequate traffic, and my job has been to find out whether the virgin territory through which the road would pass could develop an agricultural production sufficient, together with passenger and other freight traffic, to bring in a revenue which would pay all operating and overhead expenses, provide a sinking fund for the retirement of the bonds and a good profit besides. So I have been studying lands, crops, livestock, agricultural production, markets and costs, while an experienced civil engineer checked construction and operating costs and traffic movements.

So far as agricultural products for traffic are concerned the problem had resolved itself into traffic to be expected from the territory contiguous to the "Carretera" and traffic which probably will be developed near or above the terminus of the road. The area of the region adjacent to the proposed route of the Carretera is about 2,400 sq. mi., while the feeder territory at the end of the road comprises over 2,000 sq. mi. of rich valley lands and thousands of acres of mountain lands planted to coffee and other crops. Colombia is the second largest producer of coffee in the world and a large proportion of this coffee moves through Cali en route to Buenaventura and the world markets. Part of this goes direct by rail and the rest is transported by the River Cauca to Cali and would probably be carried from there to ship's side by motor trucks over the Carretera. And then the one million or so acres of land in the Cauca Valley are largely undeveloped and eventually will produce a heavy tonnage of traffic. Added to this is the traffic which will be developed from the lands along the Carretera.

Being a mountainous country the areas of agricultural land usually are found in valleys or on plateaus and it has been necessary to travel from one to the other, crossing ranges of mountains, traveling through jungles or navigating streams to determine the agricultural value of these lands. Local climatic and soil conditions must be studied, and in each instance the most profitable and best adapted type of agricultural production must be determined and a plan prepared for its development. It is of great importance that the development of these new regions be systematized and carried out under competent supervision so that standardized crops and livestock may be raised and provision made for marketing all products to best advantage. To determine what products will be most profitable involves, of course, a study of the markets both local and export. Machinery for marketing farm products in these countries generally necessitates the organization of a company to buy, grade, ship and sell them as well as to finance the growers and do a general mercantile business. In some cases cooperative enterprises may be able to serve the purpose.

In some parts of the region surveyed the trails are sufficiently good to permit the use of horses or mules. For the rough mountain country mules are preferable on account of their surefootedness. Before I came to Colombia I thought I had ridden over bad roads, but some of the trails over which I have had to travel were almost unfit for travel on foot. In some cases the trails zigzag almost straight up the mountain side and have many rocks, stumps and numerous step-like depressions filled with mud and water. Climbing one or two thousand feet in this way it is necessary to stop every 30 or 40 feet to rest the mules; trees and hanging vines must be dodged and in narrow cuts one must lift up his feet or they will be crushed against the sides of the mule. But this is nothing compared to dropping down two or three thousand feet. Whereas in climbing up it was frequently necessary to grab the saddle to keep from sliding off backwards, going down the feet must be thrust forward to keep one from tumbling over the mule's head as he slips and slides down the trail. Many of the narrow cuts are as steep as a roof and in the slick clay soil the mule puts his feet together and slides when he does not have to jump two or three feet or stumble over rocks. Those who have had much horseback riding experience will understand how necessary it is to keep a tight rein on these downhill plunges. It is marvelous how a heavily laden pack mule can keep his feet over these trails. After putting in a few days of this sort of riding some of the movie riding stunts seem tame.

Even more exhausting is traveling on foot. The civil engineer, who has been through the Amazon Valley and over the Andes, says that this is the roughest country he has seen in South America. Much of it is continually up and down hills or mountains, through or across streams, over or under fallen trees, walking on slippery logs, stumbling over roots or vines and all the time keeping a sharp lookout for poisonous snakes, biting ants, thorned plants and watching one's footing. In traversing the low coastal region there are only foot trails and all camp equipment, food and baggage has to be carried by negro "packers." This country near the coast is probably one of the rainiest regions in the world with over 300 in. of rain per year. More interesting and not quite so strenuous was the trip up the River Anchicaya in native dugout canoes. On the journey upstream many rapids were ecountered and the negro canoemen with 10-foot steel-shod poles pushed the canoes by main strength against the current and over the rocky river bottom. On this trip we were able to straighten out the location of several rivers on the map and enjoyed the thrill of walking over virgin country.

Of particular interest to the agricultural engineer is the fertile Cauca Valley with its level lands. Owing to a shortage of labor agricultural machinery will have to be used here in increasing amounts and the topography of the lands is ideal for its use. Such crops as sugar cane, rice, corn and tobacco thrive in this valley and the introduction of farm implements for producing these crops is on the increase. However, as is usually the case in new regions where agricultural machinery is just being introduced, tractors and implements are being brought in and sold by local dealers with little regard for local conditions or needs and without any provision being made for adequate instruction in the use of the equipment. I have seen this happen several times before and cannot understand why the implement companies allow these new fields for the sale of their equipment to grow like Topsy instead of getting a competent agricultural engineer to make a careful study of local conditions and recommend the kinds of implements to use. As result of this lack of introduction policy every new region soon develops on each plantation junk heaps of machinery which has been tried and failed either because it was not adapted to conditions or because the farmers have not been given proper instruction in its use.

Evidently the time is near at hand when agricultural engineers will be used to guide the development and management of commercial agricultural enterprises as engineers have directed other lines of industry.

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Operating Characteristics of Oil Heated Steam Type Dairy Equipment Sterilizers*

By A. W. Farrall[1]

THIS paper presents the results of studies of operating characteristics of oil-heated steam-type dairy equipment sterilizers. Some of the results of a theoretical study of the thermal characteristics of the dairy sterilizer as published in a previous paper and which apply to this study may be briefly summarized as follows:

1. The heat required for operation of the sterilizer is made up of
   - (a) The heat required for warming the sterilizer proper
   - (b) The heat required to warm the convecting medium to maximum temperature obtained
   - (c) Heat required to overcome heat radiation and conduction from the surface of the sterilizer
   - (d) The heat required to raise the temperature of the equipment which is being sterilized
   - (e) The heat required to evaporate water lost as escaping steam
2. The heat required to actually warm the equipment sterilized may be relatively a small part of the total heat requirement if the sterilizer is not well designed
3. The sterilizer proper should be buildt as light and compact as possible in order that it will absorb the minimum amount of specific heat
4. The sterilizer should require a small amount of water
5. The sterilizer chamber should be insulated in order to decrease the heat loss

The primary objects of the investigation were to determine the practicability of the small self-contained type dairy sterilizer, its cost of operation, the bacterial reduction efficiency, and the factors affecting its operating characteristics.

Apparatus Used. Five different types of sterilizers were studied in the laboratory as representing those in use in California, some being of separate unit construction and others self-contained.

*Second of a series of four papers, the first of which appeared in the June issue of AGRICULTURAL ENGINEERING. The material presented has been obtained as a result of a dairy industry and agricultural engineering project of the Agricultural Experiment Station of the University of California.

[1]Junior agricultural engineer, University of California. Assoc. Mem. A.S.A.E.

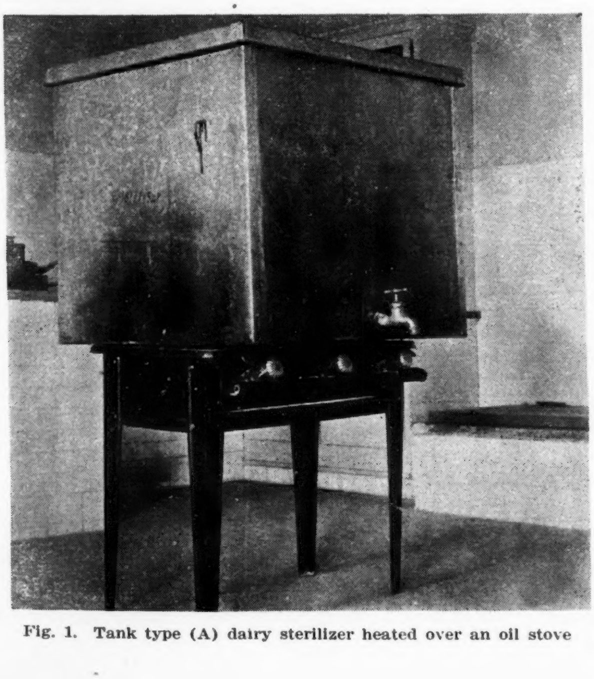

Fig. 1. Tank type (A) dairy sterilizer heated over an oil stove

Fig. 1. shows the simplest type of sterilizer, which is merely a closed galvanized iron tank. Utensils to be sterilized are placed inside and heated by the injection of live steam or by generating steam from a small amount of water placed in the bottom of the tank. In the latter case the heat is furnished by a wood or coal fire or an oil stove. The principal features to note are that the heating surface is small, the radiation surface is large, and much heat is lost due to convection air currents blowing away the hot gases from the furnace. The arrangement is quite unhandy for loading and unloading utensils.

Fig. 2 shows a type similar to Fig. 1, but which has a self-contained heating arrangement in the form of a small oil burner. The principal features of this type are that the radiating surface is large and the heating surface small; the combustion chamber is small and the hot gases of combustion do not have an opportunity to give up much of their heat. The location of the flue does not give proper elimination of burned gases, and consequently some difficulty is experienced with "smoking."

Fig. 3 shows a type of construction which by its nature provides a large amount of heating surface and consequently a good absorption of heat from the fire. The double-walled construction, together with the method of taking off the products of combustion at a high point, assists in the removal of foul gases. Superheated steam is formed in the sterilizing chamber due to the fact that the sides of the inner tank are heated above the water line.

Fig. 4 shows a typical steam boiler outfit. The principal points to note in this type of installation are, first, that the steam boiler has a larger amount of water and metal to heat and requires more heat than does the tank type dairy sterilizer. It has the advantage, however, of being able to use a lower grade of fuel than can be used with the other types mentioned. Also, steam may be had under pressure. The type of sterilizing compartment used with the steam boiler is of importance. It should be made of metal and insulated if efficient results are desired. Concrete and wood sterilizers are oftentimes used but the concrete, due to its heavy construction and high specific heat, is very slow in warming up. It also has a high thermal conductivity which causes considerable heat losses. Wood boxes have a tendency to become water soaked and deterioration is rapid.

Fig. 5 shows a flash type sterilizer which has somewhat the characteristics of a steam boiler, except that it generates steam very quickly. The large blow torch heats water and generates steam in the coil. The steam may then be led to a closed box for sterilizing equipment or may be used from a jet. The apparatus may be used for heating water by opening the control valve and passing the water through at a faster rate; closing it down causes steam to be generated.

Methods of Investigation. The various types of sterilizers were installed in the laboratory and loaded with a standard load of equipment or multiple thereof, depending upon their capacity. A standard load was considered as weighing 60 lbs., including one 10-gal. milk can, one 5-gal. milk can, one 12-qt. pail, one milk cooler and one strainer. The sterilizing operation was taken as the raising of the temperature of the compartment at the center to 210 deg. F. and holding for 20 min. The California state law requires sterilizing for 15 min. above 170 deg. F.

Burners were set to operate at the maximum opening at which they worked satisfactorily. Thermometers were installed in such a manner as to measure the temperature in several parts of the sterilizing chamber. All fuel was carefully weighed and tested. The sterilizing operation was then conducted in the regular manner starting with the sterilizer, utensils and water cold. The time measurement included that time necessary for generating the burner. All tests were repeated three times. Special tests were carried on to deter-

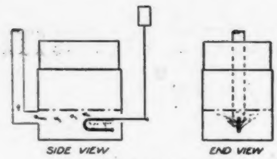

Fig. 2

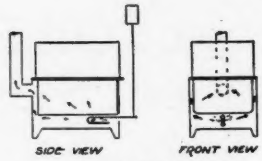

Fig. 3

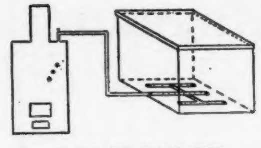

Fig. 4

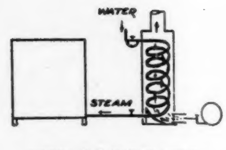

Fig. 5

mine bacterial reduction, efficiency, temperature variation within the sterilizer chamber, and effects of proper and improper operation.

Results of Tests. Fig. 6 shows the time and temperature characteristics of the five types of oil-heated sterilizers. Time includes that for generation of burner, heating to 210 deg. F. and holding for 20 min. It is apparent that the sterilizers all reached a proper sterilizing temperature of 210 deg. F. and that two of them, namely, Types E and C, reached temperatures much above 212 deg. F. or, in other words, they produced superheated steam. Type A was rather slow in heating as would be expected since the radiation losses were large and the tank was merely set over an open oil stove, making convection losses large. Type D was very slow due to the fact that the boiler and water had to be steamed up before the sterilizer could be heated. Type E, the flash heater, required the least amount of time.

Fig. 7 shows a time analysis of the sterilizing operation, including the time for generating the burner, the heating of the sterilizer and the holding period. It is evident that the total time varied from 26 min. with the flash heater to 108 min. with the regular steam boiler. A large percentage of the time required with the steam boiler outfit was that utilized in steaming up the boiler. The time for generating the burner varied from practically instantaneous in the case of the steam boiler to 6½ min. with the kerosene oil burners.

Fig. 8 shows that a thin coating of soot on the bottom of the sterilizer tank increases the time required for heating and also decreases the efficiency.

Fig. 9 shows that a warm steam boiler makes a big saving in the time required to sterilize with this equipment. Insulation about the boiler will help to keep it warm and thereby obtain results as shown in Curve No. 1.

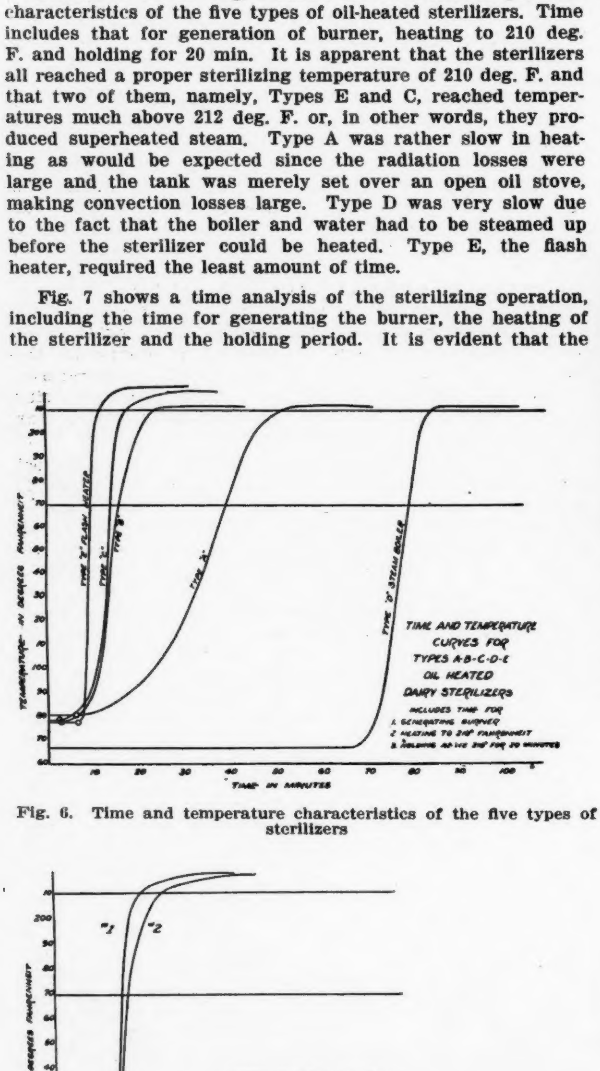

Fig. 6. Time and temperature characteristics of the five types of sterilizers

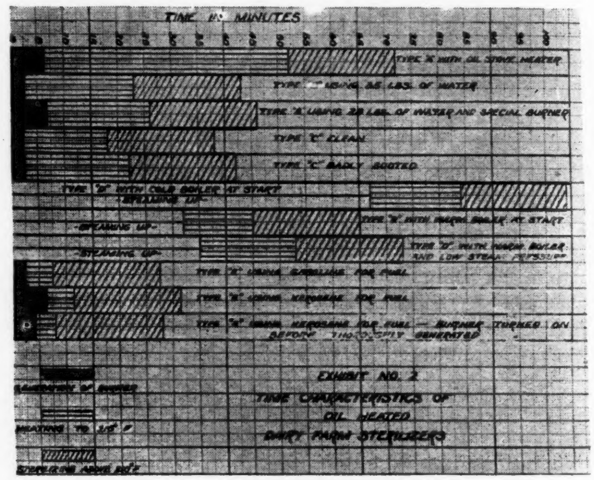

Fig. 7. Graph showing time analysis of the sterilizing operation

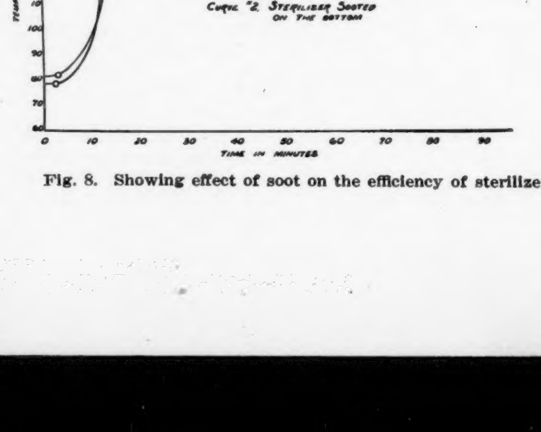

Fig. 8. Showing effect of soot on the efficiency of sterilizers

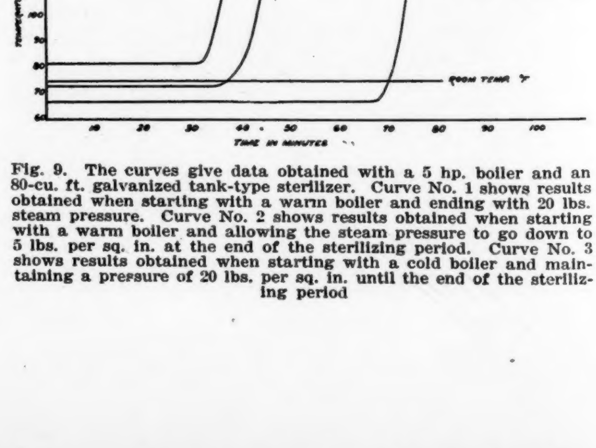

Fig. 9. The curves give data obtained with a 5 hp. boiler and an 80-cu. ft. galvanized tank-type sterilizer. Curve No. 1 shows results obtained when starting with a warm boiler and ending with 20 lbs. steam pressure. Curve No. 2 shows results obtained when starting with a warm boiler and allowing the steam pressure to go down to 5 lbs. per sq. in. at the end of the sterilizing period. Curve No. 3 shows results obtained when starting with a cold boiler and maintaining a pressure of 20 lbs. per sq. in. until the end of the sterilizing period

Table I. Fuel Consumption of Oil Heater Sterilizer

Ster. —type	Series No.	Temp. at start—°F. Room	Water	Ster.	Time in minutes to generate	to 210°F	held	total	Fuel used —lbs.	Kind of fuel	Cost of fuel per ster.—cents	Equipment sterilized —lbs.	Water in sterilizer —lbs.	Cost of fuel per 60 lbs. of equip. sterilized—cents
A	a	84.3	76.0	81.0	6.00	46.00	20	72.00	1.112	kerosene	3.50	78.0	25	2.73
B	b_1	83.2	75.2	78.2	2.64	20.37	20	43.01	1.920	kerosene	4.56	60.0	35	4.56
	b_2	65.0	64.0	64.0	6.75	20.50	20	47.20	1.640	kerosene	3.86	60.0	35	3.86
	b_3	75.0	74.0	78.0	2.00	21.50	20	43.50	2.240	kerosene	5.29	60.0	35	5.29*
C	c_1	85.2	72.5	79.0	2.19	15.70	20	37.94	1.360	kerosene	3.16	60.0	50	3.16
	c_2	85.0	75.7	82.0	2.33	19.60	20	42.00	1.690	kerosene	3.98	60.0	50	3.98
D	d	75.0	90.0	67.0	67.00	17.00	20	104.00	31.200	stove tops	27.10	300.0		5.42
	d_1	88.0	164.0	82.0	31.60	14.00	20	65.60	22.600	stove tops	19.60	300.0		3.92
	d_2	73.0	136.0	73.0	35.00	19.00	20	74.00	19.160	stove tops	16.80	300.0		3.36
E	e	79.0	74.0	80.0	2.35	5.09	20	27.43	1.800	gasoline	5.73	62.8		5.47
	e_1	78.0	75.0	78.0	6.75	4.87	20	31.60	2.440	kerosene	5.36	62.8		5.12
	e_2	80.0	74.0	79.0	4.00	4.00	20	28.00	3.260	kerosene	7.80	62.8		7.45

*Badly sooted

Fuel Consumption. Table I shows the fuel required per sterilization with the different types of apparatus under various conditions. The cost is also shown, figured on a basis of kerosene at 16 cents per gallon; gasoline at 20 cents per gallon and stove tops at 6 cents per gallon.

Results show that the cost for fuel was a small item since the minimum was 2.73 cents and the maximum was only 7.45 cents under the most adverse conditions. It is also evident that the type and efficiency of the burner has much to do with the efficiency of operation, since Type A sterilizer, with the poorest design, was most economical to operate during the tests, the reason being that a blue flame oil stove was used which was much more efficient than the common burner used with the other sterilizers. It should be noted, however, that this sterilizer required such a long time to heat that it would not be desirable to use as compared with other types.

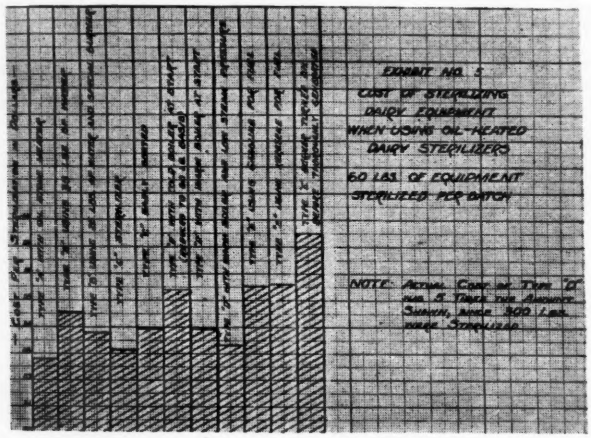

Fig. 10. An analysis of the cost of sterilizing dairy equipment

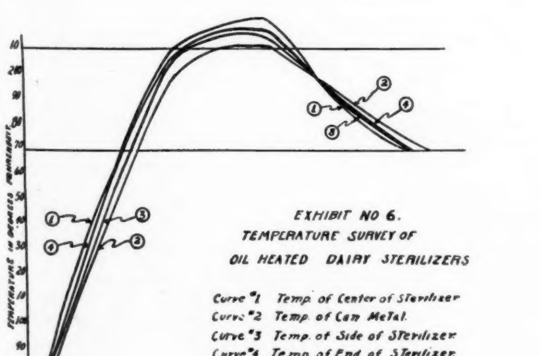

Fig. 11. Curves showing temperature variation in different parts of the sterilizing chamber

Table II. Bacterial Reduction, Oil Heated Dairy Sterilizers[2]

Series	Type of sterilizer	Room temp. —deg. F.	Wt. of equipment —lbs	Wt. of water —lbs	Min. time to 210°	held	Bact. (ave.) per cc. before	after
1	B	77	69	50	23.0	20	Uncountable	3.0
2	B	70	69	50	27.0	20	Over 1,000,000	10.0
3	B	70	69	50	30.5	20	Over 1,000,000	26.5

NOTE: Cans in the above test were rusty, had a strong odor and were only rinsed. The bacteria count was taken before and after sterilizing. The bacterial count made by the Department of Dairy Bacteriology of the University of California.

Series e_2 shows the results of turning on the burner before it was fully generated.

The cost of operation of the Type E sterilizer was practically the same when using either kerosene or gasoline.

It is evident that the dairy farmer who has only a small amount of equipment, say from 50 to 200 lbs., can sterilize quite economically with a self-contained dairy farm sterilizer. If he has more equipment than this or must have steam under pressure in order to sterilize coolers "in place," it would probably be best for him to use a steam boiler outfit.

Bacterial Reduction. Satisfactory bacterial reduction was obtained with the sterilizers as will be seen from Table II.

Results were obtained under very adverse conditions. The cans were rusty and had a strong odor, especially in Series No. 3. Samples were taken by plating 1 cc. of 400 cc. solution used in rinsing the can. Upon this basis the bacteria per can for No. 1 would be (3x400) 1200. The volume of a 10-gal. milk can is 37,850 cc. Therefore, the contamination per cubic centimeter of milk would be (1200 ÷ 37,850) 0.317.

Uniformity of Temperature in Sterilizer. Fig. 11 is a typical curve showing the variation of temperature in different parts of the sterilizing chamber. Temperatures were taken by means of standard chemical thermometers inserted through small holes in the side of the sterilizer. Curve No. 1 shows temperatures indicated by a thermometer suspended so that its bulb was in the center of the sterilizer and 10 in. from the

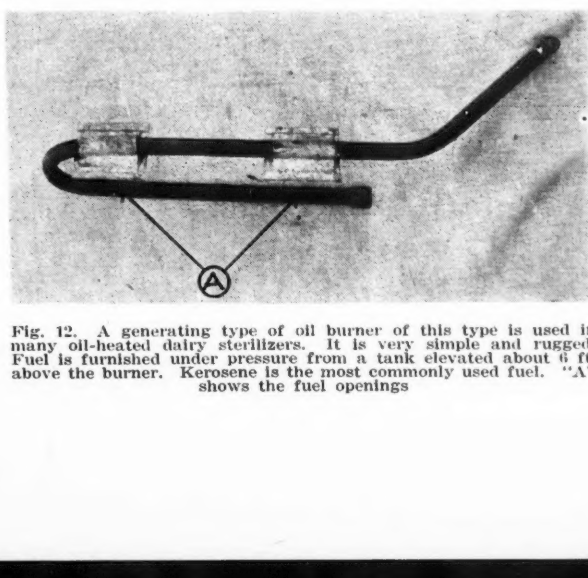

Fig. 12. A generating type of oil burner of this type is used in many oil-heated dairy sterilizers. It is very simple and rugged. Fuel is furnished under pressure from a tank elevated about 6 ft. above the burner. Kerosene is the most commonly used fuel. "A" shows the fuel openings

top. Curve No. 3 shows temperatures indicated by a thermometer bulb placed 2 in. from the side, 8 in. from the end of the sterilizer, and 8 in. down from the top. Curve No. 4 shows temperatures indicated by a thermometer bulb placed 4 in. from the bottom and in the center of one end of the sterilizer. The depth of the sterilizing chamber was 28 in., the width 28 in. and the length 34 in. It appears that the variation in temperature in different parts of the sterilizer was not great.

Temperature, Lag of Equipment Sterilized. Fig. 11 also shows the relative temperatures of the equipment as measured by a thermometer placed in a well on a 10-gal. can, and the temperature of the sterilizer as measured by thermometers suspended in the different parts of the tank. It is evident that the temperature of the can metal follows that of the sterilizer very closely. The can cools off more slowly than the sterilizer tank as would be expected.

The Burner. The heart of the oil-heated sterilizer is the burner. Much yet remains to be done toward the development of a satisfactory burner for this work. It must have the following characteristics:

1. Operate without smoke or odor
2. Be safe and free from fire hazard
3. Be of sufficient capacity to heat sterilizer quickly
4. Generate quickly
5. Be rugged and foolproof
6. Be inexpensive

Fig. 12 illustrates a popular type of kerosene burner which is inexpensive and quite satisfactory but yet causes some trouble from smoking and sooting of the sterilizer.

CONCLUSIONS

1. Oil-heated, self-contained dairy equipment sterilizers are economical to operate
2. The combustion space should be so designed as to permit efficient burning of fuel, having plenty of volume and with a flue of such design that the products of combustion are easily drawn off
3. The heating surface should be sufficient to permit rapid heating and, if possible, should be arranged to superheat the steam generated
4. A double-walled air space construction is more efficient than the single-wall construction
5. The flue should be of sufficient size to handle all products of combustion, and should be high enough to give a good draft
6. The soot should be kept cleaned from the burner and the heating surface
7. A really satisfactory burner is needed for oil-heated dairy sterilizers. The burner is of prime importance in determining the efficiency of an oil-heated sterilizer
8. The amount of water needed for the sterilizer should be kept to the minimum in order to produce quick and efficient results
9. Steam boiler outfits are recommended for large installations, but are quite expensive both in first cost and maintenance for the small dairy. They are advisable if more than 200 lbs. of equipment are to be sterilized per batch, or if steam under pressure is needed
10. Sterilizer chambers should be of galvanized iron construction, preferably insulated. Concrete is satisfactory if a large boiler and plenty of steam is available, but it is expensive to operate
11. The flash type heater is a satisfactory apparatus and is recommended where a saving in time is essential
12. A good oil sterilizer should embody the following:
    (a) An efficient burner
    (b) A small water requirement
    (c) Plenty of heating surface to produce quick and efficient results
    (d) A double-walled insulated construction, unless a large burner is used
    (e) A tank amply large to hold the necessary equipment
13. The temperature variation inside the sterilizer is not great during the heating period
14. The can metal temperature follows the sterlizer steam temperature quite easily
15. Satisfactory bacterial reduction is accomplished by subjecting utensils to live steam at 210 deg. F. for 20 min. in the tank-type dairy sterilizer

Prospects for Power Farming in China

By Ching Po Sun

AGRICULTURE, like most everything else, is different in the East from what it is in the West. The Chinese people are generally supposed to make good gardeners, and the Chinese farmers are believed to be mostly rice growers. These, together with the known facts of crowded population, naturally lead one to doubt the possibility of applying mechanical power to Chinese agriculture. But China has a large territory; therefore, in order to answer the question more adequately, a careful analysis of conditions is necessary.

Mechanical power on the farm is generally either gas, steam, or electrical; and farming can be comprehensively referred to as intensive farming and extensive farming. It is almost a universal belief that mechanical power can be applied to good advantage to places where extensive farming is practiced, for it is the scale and the kind of work to be done that determine the economical use of energy.

In China the farms are small and there is little capital available for large investments. Therefore, the landowners usually adopt the tenant system, lease their land into smaller farms, and divide the yield at the end of each cropping season. Such a system naturally will lead the owners to easily obtain returns from their land without giving much attention to it, and the tenants accordingly convert their labor into capital. So the chances are that the landowners will be reluctant to take their land back and attempt to farm it themselves with power machinery.

Furthermore, among the tenants or small farmers, as an average, there usually are about eight in the family, which is sufficient and as a matter of fact more than necessary to take care of a farm of 40 acres. If mechanical power were used instead, one or two hands only would be needed to do the work of six men. Then there would be an excess of labor within the family, and where to dispose of this surplus labor under the present condition of industrial stagnation in China would be a problem. It would seem better to keep the men on the farm rather than use mechanical equipment, for the present at least.

The above outlook is not favorable for the American people who are endeavoring to apply engineering principles to the Chinese agriculture. On the other hand, China has changed and is still changing. Some farmers do hire hands to look after their work, with a wage as high as $9.00 (Mexican) per month. It is perfectly natural that hired hands will not work as hard as their own family members and low production is often the yearly result. Owing to this fact some farmers begin to turn their attention to labor-saving devices and in many cases secure better results.

Another indication of the future agriculture in China is the recent and urgent question of reclaiming the vast areas of outer China, which means a big demand for larger power.

The application of electricity to the rural districts is invariably beyond the imagination of the Chinese peasants. The only power I think is practicable and economical for present use in China is from our domestic animals. In a word, the application of mechanical power to agricultural production in China will not take place to any great extent for some time yet.

EDITOR'S NOTE: Mr. Sun is a native of China. He came to this country in 1923. He received his bachelor's degree from the University of Minnesota in 1925 and his master's degree in 1926. At present he is at the same university studying for a doctor's degree in agronomy and plant physiology. He plans to complete work on his doctor's degree at Oxford University, England. When his education is completed he expects to return to China and take up educational work. He is a Junior Member of A.S.A.E.

The Reclamation of Alkali Land*

By James C. Marr[1]

ATTENTION has been focused on alkali land in this country chiefly because of the tendency for this condition to appear and work a hardship in our irrigated sections. In our western states where irrigation is practiced the experience has usually been that, unless some means of drainage is provided at the proper time, the land becomes waterlogged. This condition causes a concentration of alkali at or near the ground surface, which results in the gradual conversion of highly improved land into barren, desert wastes. This situation has called for (1) prevention of further damage by prompt and efficient drainage and (2) reclamation of damaged areas, which requires that the soil be drained, that excess salt be removed from the soil and that physical damage to the soil, which often occurs, be repaired. The preventive measure, drainage, is now being accomplished with fair success and has very largely put a stop to the damage, but there still remain unsolved problems in connection with the reclamation of damaged lands, which has hindered progress.

Though present knowledge of the chemistry of alkali land is still deficient, we are much better prepared in this respect than in the past. Ten years ago it was commonly believed that all alkali land could be corrected by simply reversing conditions which apparently caused them, that is, by draining the land and then washing the accumulated salts back into the subsoils, or out in the drainage water. The practice failed as often, perhaps more often than it succeeded and the reason for variable results was unknown. Through the efforts of Gedroiz, Hissink, Kelley, Breazeale, Burgess and other eminent research specialists in agricultural chemistry, the reason for failure is now known. Furthermore, possible methods of reclamation in these instances are pointed out[2].

The principal difficulty has been traced to the effects of sodium salts and, according to most recent discoveries, more particularly to sodium hydroxide, or black alkali. The old plan of reclamation has been found quite satisfactory where a material quantity of calcium in solution is present and where the soils are sufficiently porous to permit efficient leaching. These favorable conditions undoubtedly account for much of our early success in dealing with alkali soils. The practice would also reclaim soils containing principally sodium salts were it not for the fact that they become dispersed and impermeable during leaching operations, which puts a stop to further reclamation. This also, of course, is the condition where soils are already dispersed and impermeable. The dispersion is caused by the presence of sodium hydroxide, which is derived from the hydrolysis of sodium carbonate and sodium zeolite. Impermeability is brought about partly by dispersion and partly by the precipitation of colloidal material in the soil mass. It is exceedingly important to note in this connection that dispersion and impermeability take place in the presence of sodium hydroxide.

Certain chemicals when applied to soils saturated with sodium and which are properly drained and irrigated, according to laboratory results, prevent the formation of sodium hydroxide; aid in removing the source of the trouble, sodium; and repair physical damage to the soil which has already taken place. Calcium sulfate, calcium chloride, sulfur, iron sulfate, and other chemicals, through an exchange of bases, react with the sodium in the soil to form sodium sulfate, sodium chloride, etc., which may be carried out of the soil in the drainage water, or leached into the subsoils. Thereby also the formation of sodium carbonate and its subsequent hydrolysis, as well as the hydrolysis of sodium zeolite, is prevented, and dispersion and impermeability of the soil is obviated. Furthermore, these chemicals coagulate the soil particles and thus tend to correct physical damage to the soil which may have resulted from the presence of sodium hydroxide. The manner in which coagulation takes place is set forth in the Hardy-Schultz Law, viz: "Ions carrying a sign opposite to that carried by the colloid are the most active precipitants, and at the same time the higher the valency of the ion the greater its precipitating action."

In carbon dioxide we have another possible remedy and probably the most important one. When introduced in large enough quantity into a badly dispersed, impervious, sodium-saturated soil it markedly increases permeability and prevents, to a large extent, further dispersion of the soil particles by converting sodium hydroxide into sodium carbonate, and sodium carbonate into sodium bicarbonate. Sodium bicarbonate does not hydrolyze to any great extent, consequently does not cause dispersion and impermeability and may be leached out of the soil, thus permanently eliminating the troublesome sodium. A further reaction of carbon dioxide of even greater importance in bringing about these changes is that it will bring into solution the calcium as calcium bicarbonate, which will change the sodium zeolite into calcium zeolite. When carbon dioxide is absent, as is always the case in black alkali soils, it may be introduced through the action of soil bacteria on organic matter, which requires aeration of the soil and addition of organic matter. This may be accomplished by cultivation and by application of manure, or by cropping the land if it is possible to get anything to grow.

The chemical phase of the alkali problem, as previously stated, has but recently been fully recognized, and the knowl-

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[1]Associate irrigation engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

[2]A number of published papers which deal with this subject are available. A comprehensive idea of what is known of the chemistry of alkali soils may be had from Technical Bulletins Nos. 6, 9, 10, 12, 13, and 14, Agricultural Experiment Station, University of Arizona; and from Technical Papers Nos. 1 and 3 Agricultural Experiment Station, University of California.

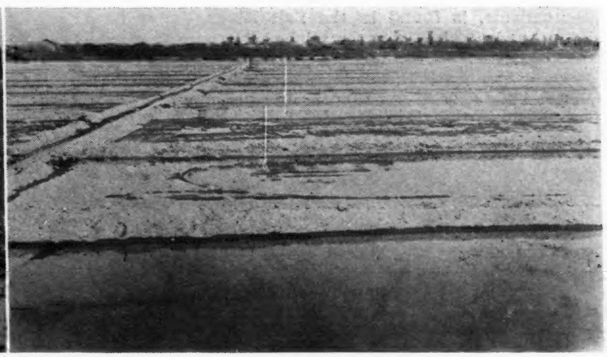

Fig. 1. (Left) Typical black alkali land covered with a natural growth of salt grass and greasewood. Fig. 2. (Right) Leaching after land shown in Fig. 1 had been leveled and bordered

Fig. 3. (Left) Accumulation of alkali on borders after land had been leached several times. Fig. 4. (Right) Unsuccessful reclamation after three years of cropping. The crop shown is sweet clover

edge that we now have is based largely on laboratory results. Its application to complex conditions found in nature is scarcely more than just under way.

That soils containing large percentages of sodium salts become deflocculated and impervious when only drained and leached, and that they are restored to productivity when, in addition, they are treated with large quantities of certain chemicals has been substantiated on the Kearney Vineyard tract near Fresno, California. When adequately drained and leached with about 4 ft. of water the fine sandy loam soil became badly puddled and impervious and failed to produce a satisfactory crop of barley. Subsequent treatments with gypsum, sulfur, iron sulfate, sulfuric acid, alum, manure and mixtures of these materials to separate plots, followed by leaching and planting to alfalfa, resulted in an excellent crop on plots where large quantities of gypsum (10 to 15 tons per acre), or sulfur (3000 lbs. per acre), or iron sulfate (2000 lbs. per acre), or sulfur and gypsum (2000 lbs. gypsum and 1000 lbs. sulfur per acre), were applied. The other treatments showed no material results. Sulfur yielded the best results, but only after it had been given time to oxidize (about 1 year). Iron sulfate gave practically as good results and was much more rapid. In 1923, before treatments, the sulfur plots produced 27 lbs. of barley per acre. In 1924, no crops were grown. In 1925 nine tons of alfalfa hay per acre was cut. In 1926 twelve tons of alfalfa hay per acre were produced. The gypsum and iron sulfate plots gave only slightly inferior yields. This yield of alfalfa is very high, and about three times the average yield for the state.

Again on the university farm, Tuscon, Arizona, where the chief forms of alkali present are sodium carbonate and sodium sulfate, the same result has been noted. The land was found to resist leaching tenaciously and to remain practically unproductive until large quantities of gypsum were applied, after which, the crops produced were heavier than for the average best irrigated land in the state.

An unusual condition, which gives further evidence in this direction, and which may in instances eliminate the cost of chemicals, is found in the Salt River Valley of Arizona. Here the drainage is accomplished by pumping from wells. The pumped water carries a large percentage of calcium and magnesium salts. It has been used for leaching alkali land with the result that reclamation has been both rapid and successful.

Unusual difficulties have been encountered at Caldwell, Idaho. Here the Agricultural Experiment Station, University of Idaho, and the Division of Agricultural Engineering of the U.S.D.A. are conducting experiments on 55 acres of exceedingly bad black alkali land. Over one hundred experiments are being carried out, which include application of various chemicals, blasting, subsoiling, supplementary drainage, straw and manure coverings, leaching under various methods of irrigation, surface washing, cultivation, and the planting of various crops. Also it is planned to pump and use for irrigation the ground water, which has been found to contain considerable calcium. So far the application of chemicals has failed to show as pronounced a benefit as elsewhere. A condition has been found which may explain the failure or slowness of chemicals to react. Owing to the presence of a dispersed, impervious soil layer 18 in. to 2 ft. below the ground surface, a perched ground-water table appears following irrigation, which persists for several weeks at a time. The impervious stratum is too far from the surface to be readily affected by surface treatments and blasting and subsoiling have proven of no avail. Shallow drainage trenches spaced at frequent intervals appear to be the only method of relieving the situation, though in this instance the calcium sulfate and sulfur applied might very well have reacted to form sodium sulfate. The continued presence of sodium in this form, due to poor drainage conditions, might eventually result in reversing the reaction to again form sodium carbonate and sodium zeolite. It is possible that chemical treatments together with surface drainage might yet result in reclamation of the Caldwell tract.

At Vale, Oregon, the application of chemicals to black alkali land, though successful to some degree, has failed to fully reclaim the land.

Granting that in sulfur, gypsum, iron sulfate and possibly other chemicals we have found a remedy for black alkali soils, we have not yet proven their use economical. For the

Fig. 5 (Left) An inspection of the bare spots (see Fig. 4) has shown the presence of a "perched" water table which appears after water has been applied to the surface and which persists for several weeks at a time. This spot is within 100 feet of a drain 8 feet deep. Fig. 6. (Middle) Shallow trenches have been found to relieve the perched water table condition on this particular piece of land. Fig. 7. (Right) Winter seeding on uncultivated ground will result in seed germination in the crevices which develop in a badly puddled soil

California experiments gypsum has cost $10 per ton, sulfur $80, and iron sulfate $50. The treatments of from 10 to 15 tons of gypsum, 1½ tons of sulfur, and 1 ton of iron sulfate per acre so far have been required to give the best results. Beyond question these figures show the cost of reclamation by the use of chemicals to be prohibitive.

Returning to the more or less natural process of reclamation in which carbon dioxide plays the important part, we cannot cite specific examples of black alkali land having been for certainty reclaimed, though there are instances in which it appears to have been done, and field experiments of this nature are not altogether discouraging. Occasionally a small tract of reclaimed land may be found in the very midst of an area known to be affected generally by black alkali. This is the case in the vicinity of our experiment station at Caldwell, Idaho.

Field experiments conducted at Caldwell are promising in this respect. We have met remarkable success in getting sweet clover started on bad spots, which previously produced nothing, not even salt grass, by first covering the surface with a 2-in. layer of well-decomposed manure, sowing the seed directly on top of the manure and applying water in accordance with the needs of the crop. Winter seeding on uncultivated ground has overcome the effect of soil crusting and baking and has yielded a good stand of sweet clover. Also land seeded and irrigated without first disturbing the surface or the natural brush has resulted in a fair crop and a saving of time and labor. Manure plowed under a straw or manure coverings after seeding have not yielded satisfactory results, excepting possibly where the covering was very light. A great deal of the difficulty experienced in successfully cropping alkali land lies in getting the crop started, consequently the demonstrations cited may prove of great importance. Whether the crops started in this manner at Caldwell will continue to do well, and, if so, whether the expected formation and reaction of carbon dioxide will take place to correct the chemical and mechanical defects of the soil, are questions which cannot be answered at the present time.

At Vale, Oregon, the most promising economical result obtained from a variety of experiments has been from seeding pasture mixtures on uncleared greasewood land, followed with frequent, copious irrigations. The pasture thus procured carried two head of stock per acre for four months during a season.

Again we have evidence of this nature in Imperial Valley, California. Here the alkali is reported to consist of sodium chloride. Repeated efforts to reclaim the land by draining and leaching alone failed. In 1926, several carefully prepared tracts were planted to rice. The growing of this crop requires that the land be submerged with water for several months during the growing season. Soil analyses show that during a single year of rice growing the alkali content was very greatly reduced in the upper three feet of soil and the surface appeared to be in excellent condition. This result has been duplicated in several widely separated sections of Imperial Valley. It has been suggested that these results may be due to compounds given off by rice plant roots, which have some influence on the chemical reactions which take place during the leaching process. In view of what we know of carbon dioxide and the possibility of its formation under these conditions it appears that it may have been the cause of the improvement.

This brief picture of the alkali situation is not complete without a word further regarding alkali in its less troublesome forms and under favorable soil conditions. It has been stated that, where a material quantity of calcium in solution is present and the soils are relatively porous, reclamation can be accomplished readily by draining and leaching. This statement is borne out by results obtained in a number of places and usually on a large scale.

Leaching of soils in Utah, that had previously been drained, has not resulted in a poor physical condition of the soil, and soils so treated have been very much improved. Utah soils contain large percentages of calcium sulfate.

In the Rio Grande Valley of Texas a similar experience is reported. Thousands of acres of alkali land were drained and reclaimed by leaching within a short period of time. Here sodium chloride and sodium sulfate occupy the soil in considerable quantities, but soluble calcium is also present in several forms.

A small tract of land known as the Segerstrom tract in Orange County, California, located in a large bean field had not produced a crop for about 25 years. Analyses showed it to contain considerable quantities of both sodium chloride and sodium sulfate and a very large amount of calcium. The tract was prepared for flooding in the fall of 1925 and during the winter was leached with about 6 ft. of water. This was applied in three different applications, the soil being cultivated between the first and second applications. Immediately following the third application, this area, together with the rest of the field, was planted to lima beans. Chemical analyses showed a great reduction in the chlorine and sulfate in the first 2 ft. and still a considerable amount of calcium throughout the whole soil column. This area produced a net income of slightly over $14 per acre after all expenses of diking, cultivation and water were deducted.

In summing up the alkali situation is must be admitted that final solution of the problem rests on the outcome of further investigations. Knowledge of the chemistry of alkali soils, particularly with respect to the phenomena of dispersion and impermeability, is still deficient. Apparently there exist possibilities of soil management, which are at present unknown, or which have not been sufficiently proven. The drainage of lands that have already become alkaline present conditions for which remedies have not always been found. A final cost of reclamation, commensurate with benefits received, cannot yet be assured.

We cannot hope to work out these details without concerted thought and action. The work involved and the knowledge required cover too wide a field of endeavor to be undertaken, with promise of success, by individuals representing any one of the branches of science or engineering. What we have needed in the past, and what we believe we have at the present time is cooperation in these investigations. In this connection I wish to pay tribute to the American Society of Agricultural Engineers as a means for bringing us closer together that this and other agricultural problems may be more readily solved.

Fig. 8. (Left) Sweet clover hay makes a good covering for alkali land which has been seeded to a crop, because it does not exclude the air and sunshine entirely and does not pack so as to offer resistance to the young plants. Fig. 9. (Right) A satisfactory crop of sweet clover raised on alkali land after three years of cultivation. The soil in this instance was sufficiently porous to allow of efficient leaching

The Seven Ages of American Agriculture*

By Samuel Fortier[1]

THE first age of agriculture discloses a small clearing on the Atlantic slope of the Alleghanies. It is dotted with charred stumps between which crops have been planted and surrounded by virgin forest as silent as the tread of the Indians who roam within it. At the edge of the forest a man in homespun garb is "slashing." He is felling the trees in leaf, lopping off the branches and cutting the trunks into dragging lengths. When the leaves and twigs are dry, a running fire will burn them with the underbrush and the blackened logs can then be dragged by oxen, piled and burned. The rhythmic swing of the axe and swish of the blade as it enters the green wood, and the echo from the nearby bush cease at the first blast of the dinner horn. Shouldering the axe and placing the discarded gallus in its proper place, he follows the path to the cabin. This is made of small logs hewn on parallel faces, notched together at the corners, with the cracks filled with wild grass or straw over which is plastered a layer of clay. After a frugal one-course meal he picks up a hoe, narrow and heavy, made by the village blacksmith, and proceeds to form a mound of turf and soil aruond each hill of potato vines. As he works he hears the whirr of the spinning wheel within the cabin or the soothing lullaby of a mother coaxing her babe to sleep.

In the second age, the landscape has changed but the condition of the farmer has not improved. Millions of acres of fine forest trees have been sacrificed to obtain so-called cleared land, and for the sake of the potash and pearlash to be got from their ashes. The leaf mold, the accumulation of ages, has been carried by storms to the sea or carted off in crops, and the stumps have given place to stones, and mile upon mile of stone wall fences surround the fields. In one of these a barefooted boy is driving a yoke of oxen hitched by a chain to a wooden plow beam. Between the wooden stilts of the plow is an old man with calloused hands and clouted knees, with rheumatism in his bones and discouragement in his heart. On account of the slow gait of the oxen and the frequent interference by stones and ledges, the process of plowing is inexpressibly wearisome to all concerned. A smooth furrow may be turned for a rod when the plowsole strikes a rock, the oxen are backed, the plow put in position and when the troublesome stone is displaced, Buck and Broad are again stopped until it is thrown or rolled by hand out of the furrow. A long day may be spent in plowing no more than a third of an acre. Harvesting the grain with a sickle is even more tedious and back-breaking. Threshing with a hand flail on the barn floor is equally slow, but it is then winter, the days are short and time of little consequence. To raise wheat by such methods and at current prices would cost more than $10 a bushel.

In the third age, farming is speeded up because the quick-stepping horse is rapidly taking the place of the slow-moving ox. Besides, a new inland empire, drained by the Father of Waters, has been discovered. So it happens that Si Perkins of New England and John McLean of Carolina sell their stony farms for what they will bring and migrate over the mountains into a new land of promise. Here state after state is added to the Union, the fertile, easily worked soil yields rich harvests, and great wealth in property is added to the Nation. Apart from human effort, credit is due to the horse and his half-sister, the mule, for this notable achievement. If the early settlers of the Mississippi Valley had depended solely on the hoe and the mattock, many of the wealthy commonwealths of today would remain territories inhabited by nomads grazing stock.

In the fourth age, the horse is still in the ascendant, but the farmer is beginning to chafe under the rate of progress and the arduous toil. He desires above all alse to shift some of the burden from his own body and place it upon that of the horse. To achieve this end, the ingenuity of the blacksmith, the mechanic and the inventor is called into action, and their efforts bear fruit. The clumsy reaper which Cyrus Hall McCormick, a Virginian blacksmith, planned in his inventive brain and wrought out with his muscular arms, had been

*The title of this article was suggested to the author in reading Garet Garret's article in the "Saturday Evening Post," of April 30, 1927, entitled "The Fourth Age of Agriculture."

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THE great industry of agriculture is being engineered. It is, in fact, the last of the larger industries to be engineered. One reason for this, perhaps, is because it presents problems of a greater variety and of a more difficult nature than are to be found in other industries. It involves the highest type of engineering knowledge and skill.

But agricultural engineers—men with engineering training and an agricultural background—are making good progress in the application of the principles and practices of engineering to agriculture. These hardy, earnest pioneers are approaching their problems with typical engineering directness and thoroughness. The accompanying picture bears witness to this fact.

This square-jawed, sturdy agricultural engineer is Professor Oscar W. Sjogren, past-president of the American Society of Agricultural Engineers, and chairman of the department of agricultural engineering at the University of Nebraska. The photographer caught him engaged in making contact with the practical phases of engineering problems associated with the application of the combined harvester-thresher, commonly known as the "combine."

This picture is typical of the agricultural engineer's method when he sets out to "get the facts."

improved from year to year, and three years before the beginning of the Civil War, 50,000 machines were in use in the United States, doing the work of 350,000 men.

About this time also relief came to many toilers in hay fields. Instead of spending the forenoon in cutting hay with a scythe and snath, they found they could sit on the spring seat of a mowing machine and allow a pair of horses to do the work of ten men. John Deere, another blacksmith lured to the prairies of Illinois from his home in Vermont, toiled at his anvil until he silenced forever the complaint of farmers that no plow would work in prairie soil after the first breaking. The steel plow worked because it was self-scouring. And so a long list of improved implements might be named which had for their object the saving of labor and increased production at a lower unit cost.

The influence of the training and experience of the engineer is felt in the fifth age of agriculture. A contraption called a pump was installed in a rice field of Louisiana a generation or so ago, and the thousands of similar installations which followed brought about a revolution in rice growing. It shifted the rice fields from the Atlantic seaboard of the Carolinas and Georgia to the gulf states, and increased production six-fold in ten years.

Two-fifths of the United States is a land of little rain. For years farmers have gambled in crop raising at the fringe of the desert. In wet years they gain, but the gain is lost in dry years. Others more venturesome cast prudence aside and establish homes in the desert. These two would have met a worse fate had not the engineer provided them with water for their thirsty soil. He not only conveyed life-giving streams to their fields, but donning gum boots and grasping a long-handled shovel, taught them how to irrigate. This new kind of farming has progressed until it enriches the nation to the extent of a billion dollars a year.

While the engineer in the West is striving to put more water on land, his brother engineer in the East is striving equally hard to get rid of it. In sweltering heat he is wading swamps alive with moccasin snakes to find a way to drain them.

Then, too, the buzzing saw mill and the creaking old grist mill live only in song and story, but the waterfall remains. Through the efforts of the engineer it has been transformed from a plaything into a powerful giant. The murmuring swish of the Pelton wheel and the faint hum of the motor do the work of thousands of horses, and the energy thus created is carried far over hill and dale by copper wires.

But the engineer has another pastime. He has spent his spare moments in tinkering with an internal-combustion engine and to his great joy it works. He thinks it can be used on farms and highways and thus give poor old Dobbin a chance to rest.

The engineer may be inarticulate but he is kind hearted. This is exemplified in the help he has given to overworked women in rural homes. For 125 years after the colonial period little was done to improve farm homes or lessen the never-ending labors of their inmates. Money was expended for bigger and better barns and labor-saving machinery, but little more than a sewing machine was added to the home. Viewed from the standpoint of the lazier and more selfish male helpmeet, this was a wonderful invention since it did not make use of a horse in its operation. Mother could run it with her two hands and an idle foot. But the engineer has been more considerate. He has installed motors back of the wash tub, the churn, and the sewing machine, and has electrified the flat iron, the ice box and the smoking oil lamp.

The vista again changes and ushers in the present—the sixth age of agriculture. The conflict is still on between animate and inanimate power. The horse and the mule have been driven from the highways but, strongly entrenched on the farms, they are making their last stand. The result is dire confusion and maladjustments. Metaphorically speaking, agriculture has taken to his bed. Many doctors and more quacks have proffered their services and their nostrums, but without avail. A year ago it seemed as if a majority of the people of this nation looked upon the patient as not only very sick but very old and feeble. They advised that he be placed on a cushioned divan carried about by Messrs. Consuming Public and Industry and whenever he showed symptoms of distress, whenever he had the least pain in his tummy, he was to receive refreshments through a congressional tube. Now, I hesitate to place my judgment in opposition to so many, but I honestly believe the diagnosis and the treatment both wrong. There is nothing organically the matter with agriculture. The lad is merely suffering from growing pains. He has outgrown his clothes and should have a new suit. Fill his body with vitalizing energy, place him on a machine with his hands on the steering wheel and a foot on the gas and he will soon astonish the world by his victories.

But to get away from the metaphor and to reiterate, there is much confusion and many maladjustments in trying to harmonize old and new ideas about farming, in breaking down the stubborn individualism of the Anglo-Saxon and forcing him to cooperate, in adjusting taxes, tariffs, and transportation charges so as not to penalize rural communities, in improving existing machines, devising new ones and in rendering power available for their use, in short in remodelling six or seven million farms by enlarging their size and changing the methods followed and the equipment used in such a way that the harvest will be greater while the cost of production is much less.

The mere mention of greater harvests, however, is enough to arouse opposition, since many believe that overproduction is the chief cause of depression. Here again I must disagree perhaps with the majority of my fellow citizens. In my humble opinion we ought to produce and produce until it hurts, providing we also lower the cost of production in a like degree. In the case of cotton, for example, if production were increased from 18 to 30 million bales and the cost per pound reduced from 15 to 7½ cents, three things would be accomplished. First, the uses to which cotton fibre is put would be greatly extended; second, the colored farmer's one mule plow would be scrapped and the driver placed on a tractor, given a job in industry or relegated to the cabbage patch; and lastly this country would be put in possession of foreign markets. Some will say that this is a ruthless procedure; but is it? If the lamb's tail has to be cut off, is it not more humane to do it guillotine fashion than an inch at a time? If agriculture has to be remodelled to meet a stupendous change from animal to mechanical power, is it not better to make the transformation as speedily as possible rather than have it drag its weary length through a long series of decades?

The uncertainty of the future obscures the seventh age of agrciulture, but by studying the past and observing the trend of the present it is possible to project the present partly through the haze of the future. The prospect is pleasing. It is a reversal of the seven ages of man as given in "As You Like It." Instead of the "sans teeth, sans taste, sans eyes, sans everything," of Shakespeare, we hear the clarion notes of Longfellow's "Excelsior." Many of the poorer farm dwellings which were nothing but inconvenient and unsanitary hovels have been torn down or burned, and on sightlier locations have been reared residences equal in quality to the better class of suburban homes. These have water, light, heat and plumbing, as well as telephone and radio, and are amply provided with labor-saving devices. The lazy, incompetent and reactionary element in rural life has been weeded out. Some of those who comprised it are resting on the bosom of mother earth, but others are in mills and shops or hoeing and weeding in gardens and on small farms. The farms are larger, they are run by big men in a big way, backed by all the machinery and power which economy demands or science and engineering can supply. Highways and transportation facilities are improved and a community house stands at each main cross road where children and adults can be entertained and amused. That noble animal and faithful servant, the horse, is still in the picture, but he follows rather than leads the procession.

Such, in brief, is the vista which the future reveals and one which in time will be a reality, but the chasm to be bridged between the present age and the one just beyond is appalling in its immensity and the difficulties which it presents.

If the prosperity of the Nation is to continue, agriculture must be placed on as sound and enduring a basis as industry. To do this it is necessary to begin with the training of young farmers who are now attending the grade schools. They must

be taught how to use their hands by spending their extra time at the forge, the wood-working bench, and the lathe. As they advance to high school and junior college, they must be well drilled in mathematics, chemistry and physics, which will pave the way for a proper understanding of the fundamentals of agriculture and engineering in their senior years at college. A knowledge of agriculture alone will not suffice. Not to teach them engineering would be equivalent to depriving them of one arm. True, crops must be grown and animals bred and reared, but the power and equipment without which human effort is unavailing pertains to engineering. If I am right in this forecast, the agricultural engineer of the present is likely to become the owner and operator of the big farm of the future.

He will be aided as the farmer is now, by state and federal experts. To bridge the chasm, it will be necessary to form an alliance with the national capital and the state experiment station. Congress has been liberal in its appropriations for agriculture as is evidenced by the recent enactment of the Purnell Bill. The U. S. Department of Agriculture can likewise be depended upon to do its utmost. Ever since it was called into existence, it has worked for and with the farmers, and none has been so poor, so down at the heel and out at the elbow that it has not been willing and anxious to extend a helping hand. In the language of a recipient of its favors, "it has puttered with his crops, doctored his critters and pizened them tarnation bugs." As a matter of fact it has been so busy helping the little fellow that it has not had enough time to see how the new tractor is working.

In the fiscal year 1922-23, the state experiment stations had a total of 5,240 projects under investigation. Field crops received the most attention with 1611 projects; horticulture second with 904 projects; plant pathology third with 452 projects; economic entomology fourth with 412 projects; and soils fifth with 310 projects. The remaining subjects in the order of their number of projects are veterinary medicine, 194; fertilizers, 193; rural economics, 186; swine, 180; dairy cattle, 176; poultry, 170; and rural engineering, 162; followed by other subjects on a diminishing scale. Such a program twenty years ago would have been highly regarded. Now it is open to criticism because conditions have changed.

In these days there are more changes in farming methods in five years than took place in 150 years of colonial rule. Farming as practiced by the Russian peasant is on the wane and is for the most part a losing game, while the application of scientific engineering and economic principles is gradually transforming a slothful giant into one of activity, efficiency and profitable endeavor. It is the duty and privilege of the agricultural engineeer to aid in this transformation. He must form an alliance with agriculture rather than engineering and with all the numerous agencies that are striving to improve the farmer's lot. This nation can boast of nothing greater than its agriculture. Handicapped as it is by the employment of obsolete methods and a lack of proper training it is producing crops to the value of 7 billion dollars a year and giving employment to 11 million people. Stated briefly, the engineer's task is to aid the farmer to fit himself by training and equipment to produce food and clothing for mankind with the same degree of cheapness, efficiency and skill that the manufacturer uses in his calling. By joining hands with the home and farm economist and the farm advisor, he must find out what the farmer's wife wants and harmonize her wants with her needs in regard to better farm homes. He must design more appropriate machinery and implements and adjust the size of the farm to their economic use. He must multiply industrial plants that manufacture soil and animal products and locate them nearer to the sources of production. In a word, he must place farming on a prosperous and profitable footing.

Spray Irrigation in the Eastern States

THE eastern states are subject to droughts of more or less severity which damage all growing crops, but especially such truck crops as lettuce, strawberries and potatoes which are materially injured by short periods without rain. To safeguard these crops from drought it is often feasible to install irrigation systems to provide a water supply to supplement the rainfall. The most common method of applying water to crops in the humid region is known as spray irrigation. Information regarding this method is contained in Farmers' Bulletin 1529-F, entitled "Spray Irrigation in the Eastern States," just issued by the U. S. Department of Agriculture.

Spray irrigation puts the water on the crops in the form of very fine drops or mist closely resembling a gentle rain. This system consists essentially of parallel lines of pipe about 50 ft. apart usually supported on rows of posts 6½ ft. high, each line of pipe being equipped with small nozzles spaced 3 or 4 ft. apart. The line is constructed so that the pipe may be revolved, thus permitting the entire width between nozzle lines to be watered uniformly. There are a number of modifications of the system, but in all cases the water is applied in the form of small drops or spray.

It is necessary that the water be supplied to the pipes under pressure, 15 lbs. per sq. in. at the nozzles. This calls for a pumping plant to lift the water from the well, stream or other source of supply and force it through the nozzles at the required pressure. Both double-acting plunger pumps and centrifugal pumps are used.

Spray irrigation has been profitable in many instances, but no attempt is made in the U.S.D.A. bulletin to state what profits have been realized or what profits a prospective irrigator may expect to obtain. Irrigation does not increase the value of all crops sufficiently to give a reasonable profit on the cost of installation, operation, and upkeep of the equipment. In order to show a profit the value of the crop must be increased sufficiently to pay (1) the cost of producing and marketing the increased yield, (2) the cost of operating the irrigation system, (3) repairs, (4) depreciation, and (5) a reasonable interest charge on the original cost of the system.

Perfume For Insect Bait

THE Japanese beetle pest, which is now spreading rapidly in the Middle Atlantic states, is one of the major uncontrolled insect menaces in this country. This insect, which has its home among grass roots, makes drives against orchards and annual crops which locally amount to complete devastation. It has failed to respond to the usual poison sprays, and no insect or animal has yet been found which feeds on or parasites the beetle. As a result, it is breaking through the strict quarantine guard and threatens wide areas of the country.

A recent discovery by the U. S. Department of Agriculture bids fair to provide a means for greatly reducing the number of beetles.

It was noted that the beetle showed a great fondness for the leaves of the sassafras tree. Since these leaves are odorous, it was surmised that one or more of the odorous materials present was attractive to the insects. After many trials, it was found that the geraniol present in the leaf was the attratent. Hundreds of other odorous materials were tried, but no single one was as good as geraniol. This rose-like odor was made even more attractive to the beetles if a little eugenol (from oil of cloves) was added to it. Insects have been observed to travel nearly half a mile to find the source of the fragrance.

It is still too early to call this bait method of drawing the insects to a common point, there to poison them, a completely successful method for their elimination, but the investigators are highly optimistic over its prospects.

A Method of Measuring Ventilation in Incubators*

By Floyd P. Bailey[1]

MANY factors enter into the artificial incubation of eggs. Some of these factors are humidity, temperature control, and ventilation. A quantitative measure of temperature and humidity may be obtained by recording thermometers and hygrometers. The determination of the air flow in cubic feet, however, is somewhat more difficult. It is the purpose of this article to outline a method used with very satisfactory results while conducting more extended tests on electric incubators.

The machines used were rebuilt Petaluma electric incubators. The change made in the machines was for the purpose of (1) obtaining a more even temperature and (2) to secure an increased air flow.

The air was originally admitted through an opening in the bottom at one end about 1¼ by 28 inches, and taken out through a corresponding opening 1½ or 2 inches higher at the opposite end of the machine. With the idea of increasing the air flow through the incubator the opening at the inlet end was closed, air being admitted through 1¼-inch galvanized iron tubes, 16 inches long placed in a vertical position. The air was taken out through an opening 9 by 15/16 inches in the top of the machine in the end opposite the inlet tubes. This change was in no way connected with the experiment as conducted later on.

Tests were then made to determine the proper location of the heating coils in the top of the machine to provide an even temperature throughout. Twelve thermometers were placed in each incubator, evenly distributed, and the coils shifted until all twelve thermometers read the same.

During the test the temperature was kept at 103 degrees F. one inch above the eggs. This position of the thermometers was selected as being the most satisfactory due to the decreased effect of infertile eggs.

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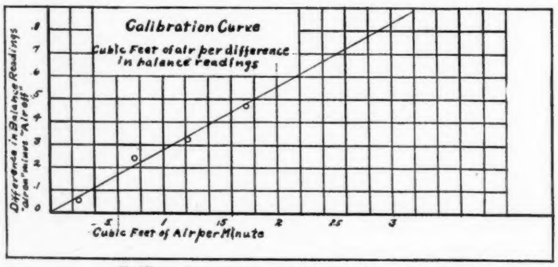
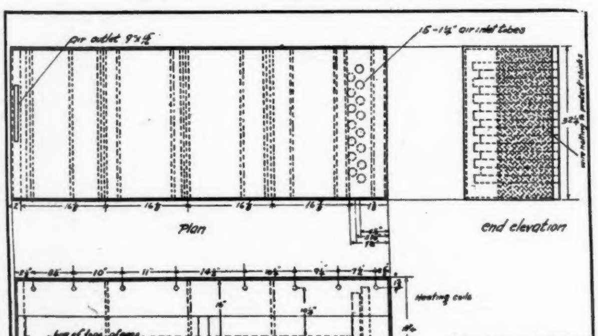


Calibration curve plotted from test data



Showing ventilation system of the electric incubator tested

Throughout the test a sensitive beam balance was used to measure the air flow. This balance was mounted on a platform so that the left pan of the balance hung directly above the center of the outlet opening. A copper plate ¾ by 1¾ inches was used. This plate was suspended from the left pan of the balance by means of a fine copper wire, which passed through a ¼-inch hole in the bottom of the balance case.

Air Flow Reduced to Cubic Feet

Date	Temperature	Average difference on balance	Cubic feet of air per minute
Machine No. 15			
Jan. 22	68	0.17560	0.63
Jan. 23	74	0.20000	0.736
Feb. 4	69	0.20467	0.74
Feb. 13	71	0.17250	0.62
Machine No. 17 7—1¼-inch tubes			
Dec. 23	58	0.44543	1.50
Dec. 27	56	0.60793	2.01
Machine No. 17 15—1¼-inch tubes			
Jan. 5	57	0.58920	2.120
Jan. 22	69	0.39390	1.420
Jan. 22	70	0.52800	1.900
Jan. 23	74	0.50002	1.800
Jan. 23	72	0.42450	1.500
Jan. 23	71	0.52960	1.906
Jan. 23	70	0.46875	1.690
Jan. 27	65	0.40309	1.460
Feb. 4	69	0.45890	1.659
Feb. 13	70	0.33665	1.220

Average cubic feet per minute—1.6685

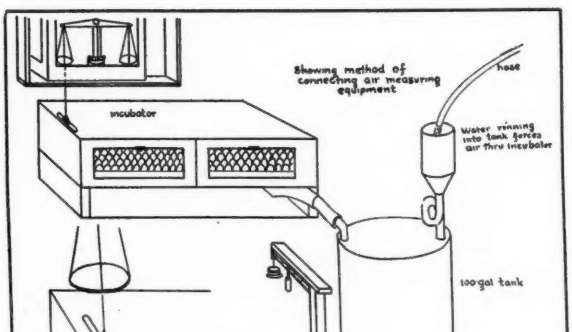
$$\text{Ratio of areas} = \frac{15}{8} = \frac{2.14}{1}$$

$$\text{Ratio of air flow} = \frac{1.6685}{.679} = \frac{2.46}{1}$$

Calibration of Balance (Air Flow)
Machine No. 17
(15—1¼-inch tubes)

Difference on-off	Total weight of water	Total cubic feet	Time of flow Hrs.	Min.	Cubic feet per minute	Average cubic feet minute	Remarks
0.05420	197.5	2.28		10	0.255		
0.05625	204.0	2.82		10	0.282	0.255	Two tests* (1 hose)
0.25000	200.0	3.20	4	15	0.727		
0.23000	200.0	3.20	4	14	0.757	0.742	Two tests* (2 hose)
0.33900	200.0	3.20	2	33.2	1.224		
0.31270	200.0	3.20	2	36.7	1.224	1.233	Two tests* (3 hose)
0.48125	200.0	3.20	1	51.8	1.715		
0.44625	200.0	3.20	1	50	1.745	1.730	Two tests* (4 hose)

*Same flow.



Arrangement of apparatus used in the tests

The pan hung in a horizontal position ⅛ inch (when balanced) above the top of the incubator, and directly over the air outlet. Readings of the balance were taken with air "on" and "off". A thin piece of cardboard was used to cut off the air. The cardboard was slipped between the pan and the opening. The method of vibrations was used.

Tests were made upon a number of machines under different conditions, and extending over a period of six months. A great quantity of data was obtained which is omitted because it is of no particular importance in this discussion.

Calibration. After the tests were completed it was necessary to calibrate the balances in order to evaluate the balance readings in terms of cubic feet of air per minute. In the calibration a 200-gallon galvanized iron tank was used. The tank was connected to the inlet tube of the incubator by a 1½-inch pipe and manifold. The manifold completely covered the lower ends of the inlet tubes. Water which was conducted to the funnel (See drawing) by means of an ordinary garden hose was admitted to the tank through a gate valve and trap. The purpose of the gate valve was to regulate the flow of water; the trap was to prevent air escaping through the inlet pipe. The equipment complete was placed on a pair of platform scales in order that the pounds, and hence the cubic feet per minute, could be determined. Care was taken to seal every connection with cup grease until the equipment was air tight. Air was then forced through the machine by running water into the tank. (In order to obtain sufficient water, one, two, three, and four garden hose were used.) At the same time readings were taken on the beam balance with air "on" and "off." The results obtained are tabulated below.

From the data obtained a calibration curve was drawn (See graph), which was used to determine the quantity of air flowing through the incubators tested. The following results are presented for the purpose of giving the reader an idea of the air flow through the machines tested as determined by the calibration curve.

This method of determining of air flow proved very satisfactory, the results being quite consistent. The air flow of the machines tested varied from 0.25 to 2 cubic feet per minute.

No doubt the apparatus could be calibrated and simplified so as to be of considerable practical value in similar experimental tests.

Developing Methods and Equipment for Extending the Use of Electricity in Agriculture*

By C. H. Churchill, Jr.[1]

THERE has been an increase in interest in electric service among farmers generally throughout the country in recent years. New York state has nearly 200,000 farms; the demands from owners and tenants of these farms for electric service have been very heavy indeed in the past few years, and the power companies have endeavored earnestly to meet it. Plans for the general extension of service into farming areas have been adopted and approximately 25 million dollars have been invested in some 11,000 mi. of rural electric lines in New York state extending service to 35,600 farms. Moreover, additional extensions are now being made at the rate of about 5,000 mi. per year.

In formulating plans for the extension of rural lines, most power companies recognize that farm customers could not pay enough for their initial use of service to make this special rural investment self-sustaining from the start, and, accordingly, the extension plans were made rather liberal on the assumption and belief that most farmers would within a reasonable time find it convenient and profitable to increase their use of service to the point where rural lines and facilities in general would be self-sustaining.

On this basis service has been widely extended and it naturally followed that the second problem before the power companies should arise, that is, to see to it that the farmers increased use of service should not be retarded by any lack of information on his part as to how to apply electric power to his tasks.

For a while the solution of this second problem was undertaken by a number of individuals working independently. The power companies had found that they did not know how to tell their farm customers how to use electric power in their business except in a very limited way. They assigned individuals to the job of finding out, by experiment or otherwise, how the farmers could use electric power in large quantities profitably. The next step was that these individuals working independently should associate and call together with them specialists along various lines. The cooperation and assistance of the state college of agriculture was needed because the college staff is familiar with the status and trend of New York agriculture and because it would act as a balance wheel against the promotion of any application which would not be for the best interests of the New York farmer. Help from the equipment companies was also needed since it appeared that new or modified equipment would be necessary.

So it came about that power company engineers, members of agricultural college staffs and equipment manufacturers representatives got together and organized what was called the "Farm Electrification Research Council." This council has been meeting at approximately one month intervals throughout the past year. At each meeting various specific applications of electric power to farming have been discussed and when it appeared that tests or experimental work were necessary before trustworthy conclusions could be drawn, one or more members of the council were assigned to the job, and they would present at the succeeding meeting (if possible) a technical report of their findings. Their methods and results were then discussed by the council and conclusions drawn with respect to the practicability, limitations, and special features of the particular application in question.

In some cases experimental work done has been a duplication of work done elswhere, either for the purpose of verifying results reported or amplifying the data on the subject or studying its applicability to our local farming situation. Concerning many of the subjects discussed no experimental work has seemed advisable but pertinent data have been secured from manufacturers and agricultural specialists.

The experimental work undertaken includes feed grinding, feed mixing, grain drying, hay hoisting, hay pressing, hay curing, silo filling, milk cooling, fruit cooling, incubators, portable motors, insect pest control, electric tractor for truck farming, and stable ventilation. Work was also done in connection with adequate farm wiring, paint spraying, etc.

Although many of these subjects will require further work, much data is now available. In order to summarize and classify this information a handbook on the application of electric power to farm operations is now being prepared by the secretary of the council. This book will include pertinent ables on the properties of materials, sections on belts and pulleys, plumbing, and other allied subjects. It will be published in loose leaf form so that new material and revised sheets may be added from time to time.

Much valuable work in connection with developing new methods and equipment is being done in many parts of the country, and it is believed it will not be many years before the farm load will be a valuable load and the widespread extension of electric service into rural areas will have been amply justified.

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Insulation of Fruit Storage Houses*

By F. G. Hechler[1]

THE walls and the ceiling of air-cooled or common fruit storage plants must be insulated in order to protect the contents from freezing during cold winter weather. To a lesser extent insulation is necessary to keep the storage at the lowest possible temperature during the early fall, otherwise on sunny days the temperature would rise considerably above the low value reached during the night.

The amount of insulation required will depend on the climate and on the length and severity of the cold spells. The inside temperature in storages of this type usually ranges between 32 and 35 deg. F. When the outside temperature is lower than that inside, there will be a loss of heat from the room to the outside air, so that eventually, unless heat is supplied, the temperature will fall below the desired value. In the common fruit storage there are two sources of heat. These are the earth which forms the floor and sometimes part of the side wall, and the respiration of the fruit. So far as the author knows there are no data available from which the amount of heat received from these sources can be computed. In the absence of these data the proper amount of insulation to use cannot be accurately determined. We can, however, examine the requirements for a satisfactory insulation and can guard against having one part of the structure well insulated and other parts poorly. The necessity for this will be obvious upon a brief examination of the insulation of some storages now in use.

Insulating Materials. All building materials offer some resistance to the passage of heat and to that extent are insulators. However, when we speak of insulators we usually mean those materials that are used primarily for the purpose of preventing heat flow rather than for their structural value. There have recently been developed materials which combine to a considerable degree both structural and insulating properties.

To the layman air spaces and insulation are usually synonomous terms. And so they are if dead-air spaces are meant, that is, if the air is absolutely at rest. In practice such a condition does not occur. Heat flowing through an air space from a warm room to the colder outdoors warms the air in contact with the inner wall of the air space; this causes it to rise to make way for the heavier cold air in contact with the outer wall. The convection current thus set up within the air space largely destroys the insulating value that it would otherwise have.

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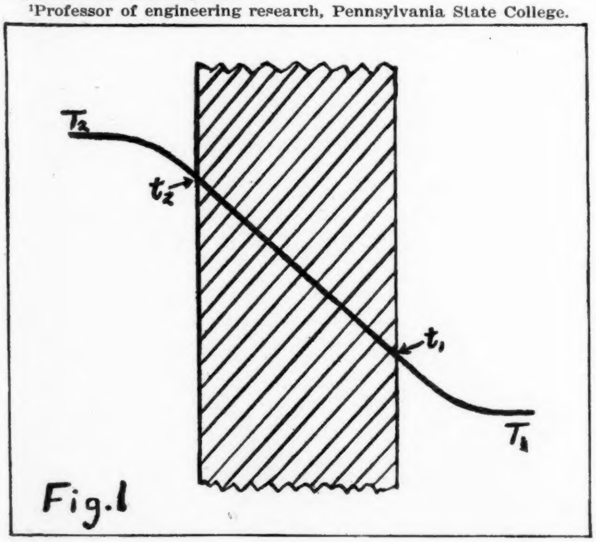


Fig. 1

Reducing the size of the air space improves the insulating value because it restricts the convection currents. In fact good insulators such as cork, hair, feathers, etc., very largely owe their insulating value to the presence of large numbers of minute air spaces which may quite accurately be described as dead-air spaces.

Methods of Heat Transfer. Heat is transferred by three methods, namely, conduction, convection, and radiation. Conduction is familiarly illustrated by holding one end of a metal rod in a flame. In a short time the entire rod becomes hot due to the conduction of heat along the metal without any visible motion of matter. A warm air furnace is an admirable illustration of heat transfer by convection; in this case the air acts as a carrier to convey the heat from one place to another. When we stand before an open fire we are warmed largely by radiant heat which has the peculiar property of passing through the intervening air without warming it to any appreciable extent. Radiation and absorption of heat are continually taking place, but since radiation is proportional to the difference of the fourth powers of the absolute temperatures, it does not play a very important part in heat transfer through insulating materials used for storage buildings.

If we examine the process of heat flow from a warm room through a homogeneous wall, Fig. 1, we find that heat is given to the warmer surface of the wall largely by convection and to a lesser extent by radiation; it is carried through the wall by conduction and finally is given off on the cool side by convection and radiation. On each surface of the wall there is a thin layer of air that is practically at rest; resistance of this layer of air causes a temperature drop at each surface. In addition to the resistances at the surfaces we have the thermal resistance of the material of the wall; the magnitude of this will depend on the nature of the material and on its thickness. As a result of many painstaking investigations engineers have determined the thermal conductivity of many materials, including air spaces, as well as the resistances at the surfaces.

These data may be applied to a fruit storage in order to find the heat loss through a given kind of construction with certain inside and outside air temperatures.

Symbolically,

$$Q = U\ (T_2 - T_1) \qquad [1]$$

in which Q = transmission, the quantity of heat in B.t.u. that will flow through one square foot of area from the air on one side to the air on the other side for a temperature difference of $T_2 - T_1$ deg. F.

U = transmittance, the quantity of heat in B.t.u. that will flow through one square foot of area from the air on one side to the air on the other side for one degree temperature difference of the air on the two sides

T_1 and T_2 = temperatures of the air on the two sides of the wall.

Equation [1] is in general use and offers no difficulties provided we can determine the proper value of U. The important problem is to find the value of the transmittance, U, for any kind of wall construction from the known conductivities of the materials comprising the walls.

For a simple homogeneous wall we may write

$$Q_1 = c_a\ (T_2 - t_2)$$

$$Q_2 = \frac{k}{d}\ (t_2 - t_1)$$

$$Q_3 = c_e\ (t_1 - T_1)$$

Q_1, Q_2, Q_3 = heat flow in B.t.u. per square foot per hour.

c_a = surface absorption coefficient, i.e., the number of B.t.u. transmitted per hour per square foot per degree temperature

difference from the air to the surface.

c_e = surface emission coefficient, i.e., the number of B.t.u. transmitted per hour per square foot per degree temperature difference from the surface to the air.

k = thermal conductivity of the material, i.e., the number of B.t.u. transmitted per hour per square foot of area per inch thickness per degree Fahrenheit temperature difference from surface to surface[2]

d = thickness of the material in inches.

For a constant flow of heat $Q_1 = Q_2 = Q_3 = Q$

Hence, $$Q = c_a (T_2 - t_2) = \frac{k}{d}(t_2 - t_1) = c_e (t_1 - T_1)$$

Solving for temperature differences and adding we have

$$\frac{Q}{c_a} + \frac{Q}{\frac{k}{d}} + \frac{Q}{c_e} = T_2 - t_2 + t_2 - t_1 + t_1 - T_1$$

$$Q = \left\{\frac{1}{c_a} + \frac{d}{k} + \frac{1}{c_e}\right\} = T_2 - T_1$$

$$Q = \frac{T_2 - T_1}{\frac{1}{c_a} + \frac{d}{k} + \frac{1}{c_e}} = U(T_2 - T_1) \text{ from}$$

Equation [1]

Hence, $$U = \frac{1}{\frac{1}{c_a} + \frac{d}{k} + \frac{1}{c_e}}$$

Where $\frac{1}{c_a}$ and $\frac{1}{c_e}$ are the surface resistances and $\frac{d}{k}$ is the thermal resistance of the wall from surface to surface. The resistances are the reciprocals of the corresponding conductivities.

For a compound wall made up of layers of materials with different resistances

$$U = \frac{1}{\frac{1}{c_a} + \frac{1}{c_e} + \frac{d_1}{k_1} + \frac{d_3}{k_3} + \ldots + A_1 + \ldots} \quad [2]$$

$$= \frac{1}{R_a + R_e + d_1 R_1 + d_2 R_2 + \ldots + A_1 + \ldots}$$

Where R_a and R_e = the resistances to the flow of heat offered by the layer of air at the surface of the walls

$R_1, R_3 + \ldots$ = the resistance to heat flow of the various materials

$d_1, d_3 + \ldots$ = the thickness in inches of the materials

$A_1 + \ldots$ = the heat resistance of the different paper layers and air spaces

Equation [2] for determining the transmittance U is of the greatest importance in determining the relative insulating values of the various wall constructions used in practice. The conductivity, and its reciprocal the resistance, has been determined for most materials. For convenience the values for a few materials are given in an appendix to this paper.

To illustrate the use of the formula it will be applied to a few typical constructions.

Wall A—⅞-in. siding, paper, 6 in. granulated cork, paper, ⅞-inch siding.

$$U = \frac{1}{(R_a + R_e) + 2 \times \frac{7}{8} \times R_1 + 6 \times R_3}$$

[2]Conductivity is often defined with the foot instead of the inch as the unit of thickness. This is more logical but usage has established the inch unit among engineers.

Where $(R_a + R_e) = 1$ = sum of two surface resistances

$R_1 = 1$ for wood

$R_3 = 3.0$ for granulated cork

$$U = \frac{1}{1 + 2 \times \frac{7}{8} \times 1 + 6 \times 3} = \frac{1}{1 + 1.75 + 18} = \frac{1}{20.75}$$

= 0.048 B.t.u. per Hr. per deg. F. per sq. ft.

$Q = 0.048 (T_2 - T_1)$ B.t.u. per hour per square foot of area

Wall B—12-inch brick work, ¾-inch air space, ½-inch plaster

$$U = \frac{1}{(R_a + R_e) + 12 \times R_1 + \frac{1}{2} \times R_2 + A_1}$$

$(R_a + R_e) = 1$

$R_1 = 0.2$

$R_2 = 0.435$

$A = 1$ for air space

$$U = \frac{1}{1 + 12 \times 0.2 + \frac{1}{2} \times 0.435 + 1}$$

$$= \frac{1}{1 + 2.4 + 0.22 + 1} = \frac{1}{4.67}$$

= 0.214 B.t.u. per hr. per deg. F. per sq. ft.

REQUIREMENTS FOR A GOOD INSULATOR

An ideal insulating material should possess the following characteristics:

(1) It should have a high insulating value
(2) It should not readily absorb moisture
(3) It should be fire resistant
(4) It should not harbor vermin or rodents
(5) It should be odorless
(6) It should be reasonable in cost
(7) It should be easily applied by unskilled labor
(8) It should not deteriorate with time

Very few materials can meet all of these requirements. In the insulation of storages for mechanical refrigeration, cork, usually in the form of compressed sheets, is most extensively used. For air storages granulated cork, or cork dust, is an excellent material provided the cost is not too high. Cork possesses a natural oil that makes it highly moisture resistant; nevertheless care should be taken to protect it from moisture by using a waterproof paint on the sheets and waterproof paper with the granulated material.

Moisture quickly destroys the insulating value of a storage wall and with some materials such as sawdust causes a physical deterioration that is extremely harmful. Therefore, every precaution should be taken to prevent its entrance.

Shavings are better for insulating a wall than sawdust, because they are easier to handle and are not so seriously damaged by moisture. They are usually drier when received than sawdust and they should if at all possible be kiln-dried before use and then kept dry by using a good quality of heavy waterproof building paper.

There are a number of excellent patented insulating materials available. Some of these come in sheet form and to some extent replace lumber. Others, usually gypsum products, come dry and are mixed with water and poured into the wall while plastic; in a short time they harden, becoming an integral part of the wall.

It is impossible to fix arbitrarily the type of wall that should be constructed. Local conditions and price fluctuations of materials must always be taken into account. But in order that the fullest advantage may be taken of available materials, the methods of computing the relative heat losses through the various types of constructions must be understood. Otherwise it is quite likely that improper materials will be used or that materials will be used in an inefficient way. It seems almost needless to say that the relative insulating values of the walls and ceilings should be about the same, yet in practice it is not unusual to find that one part of the storage is three or four times as efficient as some other part. The transmittance values for the walls and ceilings of several fruit storage houses have been computed by Equation [2], using the conductivity values from Table I, and are given in Table II. A comparison of the values will show that storages

1, 2, 5 and 6 have the wall and ceiling insulation well proportioned though the actual insulating values of the constructions used in the different storages vary widely. Storages 3 and 4 are excellent examples of a poor distribution of insulation between the walls and the ceiling, the relative values in both cases being about three to one. A little care in designing will prevent such errors.

Undoubtedly insulation is of first importance in constructing fruit storages, but we should not lose sight of the fact that depreciation, upkeep and insurance are also to be considered and that these items may sometimes justify the use of a type of construction that is inferior from an insulation standpoint. Extremely cold weather is usually of rather short duration, hence it may be more economical to limit the amount of insulation to what is deemed sufficient for ordinary conditions and supply artificial heat, as with oil stoves, during severe cold spells.

The best we can do perhaps is to point out that air spaces are relatively inefficient as insulators, that they are of value only when air tight and comparatively small, and that in general masonry of all types, including solid concrete and concrete blocks, is a poor insulator. Hollow tile, in spite of the air spaces, has about the same insulating value as brick. The only openings into the storage should be the doors and these should be rigidly constructed and well insulated. The regular cold storage type of patented door is most suitable. Windows should be omitted; if they must be used they should be double and in addition should have a well-insulated blank for sealing the opening when not needed for admitting light.

It may be of interest to note that the following materials would have approximately the thicknesses indicated for equal insulating values: Cork, 1 in.; shavings, 1⅜ in.; wood, 3-1/3 in. brick, 16½ in.; hollow tile, 16½ in.; concrete, 26½ in.

TABLE I. Thermal Conductivity of Materials

(Mean values to be used for computing the insulating value of walls when free from moisture.)

Material	Conductivity B.t.u. per hour per sq. ft. per inch per deg. F.	Resistance per inch thickness = 1 / conductivity
Cork, granulated	0.33	3.03
Cork board	0.30	3.33
Celotex, 7/16 in. thick	0.33	3.03
Wall boards, such as "Upson", "Beaver", etc.	0.50 to 1.00	2.00 to 1.00
Linofelt (flax fibre)	0.30	3.33
Cabot's car quilt	0.33	3.03
Fibrofelt	0.33	3.03
Flaxlinum	0.33	3.03
Charcoal, loose	0.36	2.78
Lithboard, waterproofed	0.38	2.64
Sawdust, dry	0.40	2.50
Planer shavings, dry	0.40	2.50
Wood	1.00	1.00
Mineral wool	0.27	3.70
Plaster	2.30	0.435
Concrete (in wall) about	8.00	0.125
Bricks (in wall)	5.00	0.200
Tile, hollow in wall	5.00	0.200
Concrete blocks	8.00	0.125
Stone	8.00 to 15.00	0.125 to 0.067
Hair felt	0.25	4.00
The sum of the two surface factors may be taken as	1.00	1.00
All air spaces regardless of width as	1.00	1.00

TABLE II. Relative Insulating Value of Some Air Storage Constructions

Data on construction and cost taken largely from Bulletin No. 146, Michigan Agricultural Experiment Station.

Storage	Capacity, bushels	Cost per bushel	Wall: Construction outside to inside	Wall: "U"	Ceiling: Construction top to bottom	Ceiling: "U"
1			Siding, paper, 6 in. gran. cork, paper, siding	0.048	4 in. gran. cork Boards, paper	0.066
2	8,000	$0.25	8 in. tile, 1 in. air with ¼ in. quilt, 4 in. tile	0.148	Boards, paper, boards, 10 in. air, paper, boards, ½ in. air, plaster	0.138
3	10,000	0.40	Boards, 2 in. air, 2 in. hair felt, 6 in. air, boards	0.08	Boards, paper, 8 in. air, paper boards	0.222
4	12,000	0.42	Plaster, 12 in. tile, plaster	0.261	Boards, paper, boards, 3 in. air, 1 in. hairfelt, 2 in. air, wall board	0.097
5	5,000	0.32	Boards, 2 in. air, ½ in. Celotex, 4 in. air, ½ in. Celotex, boards	0.135	Roofing, boards, 2 in. air, ½ in. Celotex, 4 in. air, ½ in. Celotex, boards	0.125
6	8,000	0.25	8 in. concrete block, 2 in. air, 6 in. blocks	0.266	Boards, 6 in. air, boards	0.286
7	11,000		8 in. tile, 2 in. air, 8 in. tile	0.192	Boards, paper, boards, 10 in. air, sheetrock	0.241
8	7,000	0.43	24 in. concrete (basement), boards, paper, boards, paper, 6 in. sawdust, boards	0.25 / 0.054	8 in. sawdust, paper, boards	0.0455
9	3,500		8 in. brick, 4 in. shavings, 8 in. concrete block, asphalt paint	0.073	Boards, paper, boards, 8 in. shavings, boards, lath, plaster	0.042

Michigan's Land Economic Survey

MUCH has been said and written in the past few years about Michigan's policies for land utilization in the cut-over districts. With over 700,000 acres already reverted to the state for non-payment of taxes; with 10,600 farms being abandoned during the last census period; with one acre in five of all the land in the state now delinquent for taxes; with increasing demands for fishing, hunting, camping and outing territory; with the past history of wholesale failure in the agricultural settlement of poor sandy lands; with certain counties on the verge of bankruptcy due to lack of taxable resources; and with the acreage of idle and loafing lands still increasing, the Michigan Land Economic Survey was created to get and report the essential facts.

Those in charge of the survey concluded that the function of the survey should be to gather and present the essential facts as to the land and the history of its use. It was recognized that there were two type of information to be gathered: (1) physical conditions, such as soil, lay of the land, original and present growth, water resources and (2) economic conditions, such as assessed valuation, intent in ownership, tax history, history of utilization and trends in population. It has been the policy of the survey to select the first counties worked so that a general average of conditions might be obtained for northern Michigan before the survey had completed the whole cut-over region.

The unit of inventory is a county and on the completion of each county, maps and reports are to be published for distribution.

All of the information—the soil maps, the lay of the land maps, the cover maps, the assessed valuation and "intent in ownership" maps and other recorded data—when considered together give a very intimate picture of the county's land and forest resources, their present condition and probable future utility. No such data has ever before been available in this or any other state.

The work of the survey to date indicates among other things, that (1) successful land use and soil character are very intimately related and the practical and impractical use can usually be anticipated; (2) soils, good, medium grade and poor for agriculture or for forest growth can be readily identified; (3) the survey's soil maps check very closely with the local assessors' valuation indicating that local experience has now established the relative value of the prevailing land types; (4) summer resort development along good lakes often yield more revenue to the county than much greater areas of poor soil farms; (5) the areas, in which land abandonment and reversion to the state for non-payment of taxes is likely to occur, can be forecasted; (6) generally speaking, absentee owners, including former lumber companies, own the least valuable classes of land.

The Influence of Flocculation on the Compression Strength of Gila Clay Loam

By C. W. Botkin[1]

IT IS generally known that flocculation improves the tilth and crumb structure of soils and that deflocculation causes soils to become plastic when wet and very hard and difficult to till when dry. A search of the literature, however, reveals very few data concerning the influence of the state of flocculation on the hardness or cohesive strength of soils. This property is of great importance in the tillage of soils, in the making of adobe building material, and in the construction of foundations, reservoirs and roads. Consequently, it was thought desirable to make a quantitative study of this property. The data presented in this paper are the results of tests on the compression strength of Gila clay loam deflocculated by alkali and flocculated by aluminum sulphate.

Previous Work. The hardening influence of alkali on fine-textured soils is well known, but the author was unable to find reports of quantitative measurements. Both Noll (1)[2] and Russell (2) have shown that liming decreases the plow draft in certain soils which tend to become acid. Middleton (3) has made a study of the principal factors influencing the binding power of soil colloids and has reviewed the various methods that have been used for determining the breaking strength or binding power of soils. He employed a method described by Jackson (4) for determining the strength of road-building materials. In order to obtain duplicable results, Middleton found (a) that the soil briquettes at the time of molding should contain sufficient moisture to assume the minimum volume under a pressure of 2,000 lbs. per sq. in., (b) that the pressure (2,000 lbs.) in making the briquettes should be applied for the same length of time (60 sec.), and (c) that the method of drying should be such as to prevent cracking of the briquettes. He also states that the colloid should have the same degree of dispersion, but does not give data concerning the influence of this factor. Middleton shows that the breaking strength increases with the amount of colloid present in the soil; that it varies with the source of the colloid, and with the size, grading, and surface of the mineral grains.

[1]Professor of chemistry, New Mexico College of Agriculture and Mechanic Arts.

[2]Numbers in parenthesis refer to the list of references at the end of this article.

TABLE I.
Briquettes 25 mm. long, 25 mm. in diameter

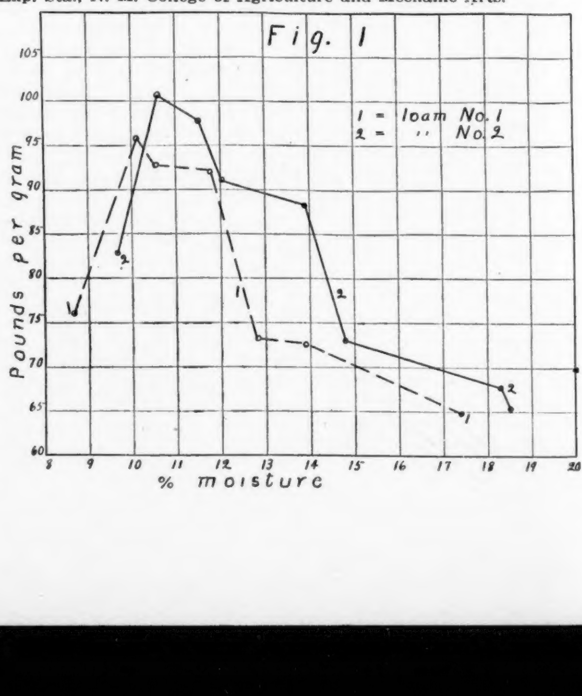
Soil	Test No.	Water found	Average weight of dry briquette	Average load per briquette	Breaking load per gram
		—per cent	grams	lb.	lb.
Loam No. 1	1	8.68	24.70	1872	75.8
”	2	10.13	24.80	2373	95.7
”	3	10.51	24.09	2239	92.9
”	4	11.80	24.50	2255	92.1
”	5	12.80	23.34	1708	73.1
”	6	13.90	22.59	1642	72.6
”	7	17.40	21.59	1401	64.8
Loam No. 2	8	9.69	24.30	2012	82.8
”	9	10.60	24.90	2505	100.6
”	10	11.53	24.61	2410	97.9
”	11	12.01	23.99	2183	91.0
”	12	13.90	22.96	2030	88.4
”	13	14.80	22.51	1643	73.0
”	14	18.30	21.24	1442	67.9
”	15	18.50	20.79	1360	65.4
”	16	9.61	24.40	1827	74.9
Loam No. 2	17	10.32	24.40	2415	99.0
with	18	11.53	24.30	2167	89.1
0.5%	19	14.20	23.54	1973	83.8
$Al_2(SO_4)_3$	20	15.30	22.71	1742	76.7
	21	17.20	22.05	1518	68.8
	22	18.50	21.40	1407	65.7
Loam No. 2	23	8.69	24.30	2048	84.3
with 0.5%	24	9.99	25.00	2663	106.5
$Al_2(SO_4)_3$	25	10.76	24.70	2653	107.4
after	26	12.17	23.70	2073	87.5
percolation	27	13.18	23.00	1860	80.9
	28	11.01	24.90	2058	82.7
	29	12.23	24.90	2367	95.1
Loam No. 2	30	12.84	24.20	2057	85.0
with 0.5%	31	13.70	23.46	1880	80.1
NaCl	32	16.40	22.06	1587	72.0
	33	17.00	22.69	1570	69.1
	34	19.50	21.17	1277	60.3
Loam No. 2	35	9.86	24.90	1897	76.2
with 0.5%	36	10.22	24.20	2257	93.3
NaCl, after	37	11.61	24.10	2557	106.1
percolation	38	13.06	23.50	2192	93.3
	39	13.57	21.40	1970	92.1
Loam No. 2	40	8.84	24.73	1950	78.9
with 0.5% NaCl,	41	8.88	23.63	1907	80.7
after 2 extrac-	42	9.40	24.92	2480	99.5
tions with water	43	9.48	24.32	2225	91.1
Loam No. 2	44	8.36	24.35	2565	105.3
with 0.5% Na_2CO_3,	45	9.18	24.88	2250	90.4
after 2 extrac-	46	10.72	24.30	1900	78.2
tions with water	47	10.90	24.00	1760	73.3

Experimental Work. The compression data reported in this paper were obtained by a modification of the method employed by Middleton.

The tests were made on uniform samples of Gila clay loam. The mechanical and chemical composition of these samples and their behavior with flocculating and deflocculating reagents have been published elsewhere (5). Loam No. 1 contained 0.08 per cent of soluble matter and was slightly flocculated; loam No. 2 contained 0.17 per cent of alkali and was somewhat deflocculated[3]. Compression tests were made as follows: On both loams without added reagents, (Tests Nos. 1-15, 48-51); on Loam No. 1 containing 0.5 per cent sodium chloride (Tests Nos. 52, 53), and with an addition of 0.5 per cent sodium chloride followed by leaching with water (Tests Nos. 54, 55); and on Loam No. 2, (a) containing 0.5 per cent of aluminum sulphate (Tests Nos. 16-22, 56, 57), (b) with an addition of 0.5 per cent of aluminum sulphate followed by leaching with water (Tests Nos. 23-27, 58, 59), (c) containing 0.5 per cent sodium chloride (Tests Nos. 28-34), (d) with an addition of 0.5 per cent of sodium chloride followed by leaching with water (Tests Nos. 35-39), (e) with an addition of 0.5 per cent of sodium chloride and enough water for saturation, followed after 24 hr. by two treatments in which the soil was shaken with a large volume of water and filtered (Tests Nos. 40-43), and (f) with the addition of 0.5 per cent sodium carbonate followed by the treatment mentioned in (e) (Tests Nos. 44-47).

In Tests Nos. 1 to 48 (Table I) varying percentages of water were used in making the briquettes in order to secure results for the maximum density when using a briquetting-pressure of 2,000 lbs. per sq. in. The briquettes in these instances were made by mixing 100 gm. (on a moisture free basis) of the pulverized air-dry soil with the calculated amount

[3]Loam No. 1 is the "good soil" and Loam No. 2 is the "poor soil No. 1," analyses of which are given on p. 15, Bul. 160, Agr. Exp. Sta., N. M. College of Agriculture and Mechanic Arts.



of water necessary to secure the desired percentage of moisture. The water and soil were then mixed with a glass mortar and pestle so as to secure a uniform distribution of moisture. The mixture was transferred to a 150 cc. beaker and placed in a desiccator over water for 42 hrs. The briquettes were then made with an Olsen briquetting machine using a pressure of 2,000 lbs. per sq. in. for 60 sec. First, three briquettes were made using 20 gm. of the mixture. The length of each of these briquettes was measured with a micrometer, and from the average of these lengths the weight of mixture required for a briquette 25 mm. in length was calculated. Using this calculated quantity three briquettes were made from each mixture. The briquettes were all 25 mm. in diameter. The 20-gm. briquettes were used to determine the percentage of moisture present at the time of briquetting. The other briquettes were allowed to stand for 24 hr. in a desiccator over water. They were then transferred to a drying oven and at room temperature subjected for 24 hr. to a very slow current of air nearly saturated with moisture. The briquettes were left in the oven at room temperature for another 24 hr. without the current of air, then the temperature was slowly raised for a period of 18 hr. and finally maintained for 3 hr. at 110 deg. C. The briquettes were cooled over sulpheric acid in a desiccator and weighed to obtain their "dry weight." The briquettes were then subjected to the compression test in an Olsen universal testing machine. During the test the briquette rested on the center of a spherical bearing block. The maximum pressures obtained at the breaking point are recorded in Table I. The values given for each test are the average of the results obtained with three briquettes.

The briquettes in Tests Nos. 48 to 60 were given a different treatment. The soils were well mixed with enough water (30 per cent) to reach the saturation point, simulating a condition which exists after irrigation or heavy rainfall. The samples were allowed to stand for 24 hr. in beakers at room temperature. The mud was then placed into a mold with a trowel using only enough pressure to fill the mold. The two exposed faces of the briquette were smoothed off with the trowel, and the briquettes dried in the laboratory at room temperature. They were turned about three times a day for the first five days. After 20 days in the laboratory the bricks were baked in the sun for a period of five days. Then the "dry weights" were obtained and two opposite faces of each briquette capped with plaster of paris in order to have plane faces for the contacts in breaking. After the caps had hardened the briquettes were subjected to the compression test in the same manner as the 25 mm. briquettes. The data obtained in these tests are given in Table II.

Results and Discussion. The data (Table I) and the curves (Figs. 1, 2 and 3), showing the relation of the percentage of moisture to the breaking strength, verify Middleton's conclusion that the maximum compression strength is obtained with a "critical amount" of moisture which corresponds to the percentage for maximum density. This critical amount is about 0.5 per cent higher for Loam No. 2 than for Loam No. 1, which contains about 0.1 per cent more alkali; and is about 1.6 per cent higher for Loam No. 2 when it contains 0.5 per cent of added sodium chloride. Leaching out the sodium chloride decreases the critical amount of moisture. This decrease is very pronounced in tests Nos. 40 to 48 where the removal of the alkali was most complete; the critical amount being below 10 per cent. Aluminum sulphate does not appear to greatly alter the critical amount of moisture. The high percentage of moisture (30 per cent) used in making the briquettes for Tests Nos. 48 to 60 is, no doubt, partly responsible for the comparatively low breaking strength of these briquettes.

The critical amount of moisture does not appear to be definitely related to the state of flocculation. These loams are well flocculated when containing 0.5 per cent of sodium chloride or aluminum sulphate, and are also flocculated after percolation, if aluminum sulphate has been added previously. These soils containing sodium compounds become highly deflocculated on percolation or extraction with water. In the dispersed condition the colloids are in a high state of hydration and consequently one would expect a higher critical amount of moisture. However, the opposite appears to be true. Moreover, the flocculation resulting from aluminum sulphate does not increase the critical percentage of moisture.

It is evident from the curves in Fig. 3 and from the data of Table II that the breaking strength of this loam is decreased by the presence of sodium chloride and is increased by the removal of this salt or the carbonate by percolation or extraction with water. This behavior indicates that flocculation of the colloids decreases their binding power and that deflocculation increases it.

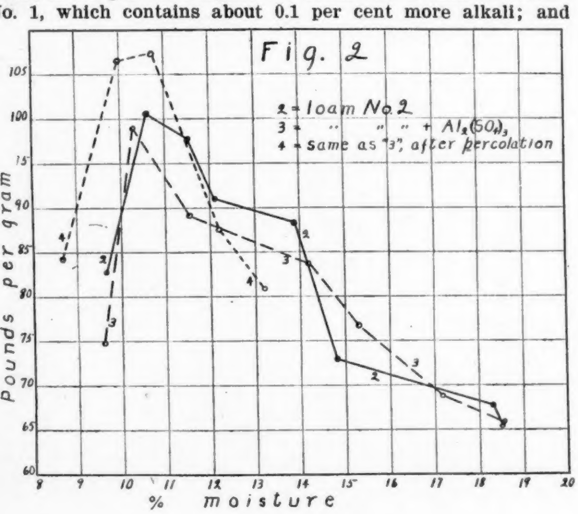
The flocculation with aluminum sulphate results in a small decrease in the compression strength of Loam No. 2 when the aluminum sulphate and its reaction products are present (Fig. 2 and Table II); but after percolation, this loam, to which aluminum sulphate has previously been added, shows an in-

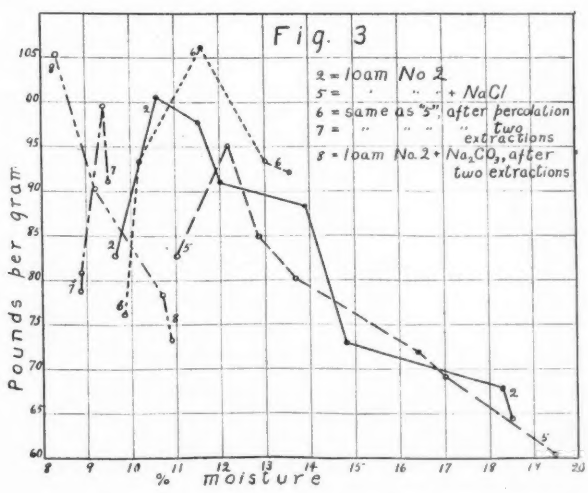
(Continued on page 257)

TABLE II.

Briquettes 2 by 2 by 2 inches

Soil and treatment	Test No.	Weight of dry briquette	Load per briquette	Breaking load per gram
		grams	lb.	lb.
Loam No. 1	48	203	1,780	8.76
"	49	202	1,747	8.65
Loam No. 2	50	204	2,080	10.19
"	51	201	2,150	10.69
Loam No. 1 + 0.5% NaCl	52	199	1,570	7.88
" "	53	201	1,640	8.15
" + 0.5% NaCl, after percolation	54	196	1,790	9.13
" " "	55	196	1,895	9.67
Loam No. 2 + 0.5% $Al_2(SO_4)_3$	56	199	1,985	9.97
" "	57	207	1,900	9.18
" + 0.5% $Al_2(SO_4)_3$ after percolation	58	200	2,020	10.10
" " "	59	201	2,080	10.34





Agriculture as a Basic Industry*

By Arthur Huntington[1]

AGRICULTURE is a wide-flung industry producing many different products under widely varying conditions with a wide range of efficiencies and a correspondingly wide range of living standards.

The agriculturist is an individualist. He follows rules of his own making and considers himself as something apart from those industries and businesses in the world at large with whom he has to deal. For centuries he has pursued his calling, regarding it as a mode of living. The time has now arrived when the industry—agriculture—must accept new standards, practice new methods, and accept new leadership.

Agriculture is basic, and those things that are vital to it are vital to the nation. There are four fundamental requisites of food and clothing supply that are vital factors to the welfare of all people: (1) Quantity, (2) quality, (3) cost, and (4) the well-being of those engaged in the industry.

For the present and for years to come the supply is ample. Land is still available in large quantities, and the yields can be increased with little effort. Reasonable economy of what is now available will maintain a population much in excess of that which is now being maintained. Famine or food shortage is a transportation problem and not a shortage in the world food supply. The development of new markets and new uses for agricultural products, outside of the need for food and clothing, are at present of greater national and world importance than the problem of supply.

Quality is also well taken care of. Nearly all of the problems of bettering quality is one of didactics of manufacture, of home preparation rather than one of agriculture. The quality of raw materials coming from the farm is such as to "lead" the manufacturers and dietitians for many years to come and is being augmented by the development of new and better products.

The cost to the ultimate consumer is satisfactory as proven by the fact that more time and money is being expended in making the product more attractive to the eye rather than to reduce the cost, and further by the fact that many products are available at prices much below those at which the products are generally purchased in the regular channels of trade.

In many instances the value of the products of agriculture, more particularly food, are only a small part of the cost and an even smaller part of the price paid.

The well-being of those engaged in agriculture is not only an agricultural problem but also a great national problem. It has been a problem of national importance to each nation and to each generation although not always recognized. To meet this problem properly, two things are of vital importance—desire and income.

A large number of persons engaged in agriculture not only have a desire for higher living standards but also have a high appreciation of those things that stand for the better things of life. While others seem lacking to the place that they do not avail themselves of many things that are relatively easily attainable, some even accept without protest standards much below those which are freely accorded to the workers in the other industries. Few persons outside of the field of agriculture are acquainted with the privations of rural life and little effort has been made to make available to the rural home those things that are commonly accepted and expected in the city. Many of these comforts and conveniences are only partially adapted to rural use and must be redesigned. Also much new apparatus must be designed and made available.

But why create a desire unless the means for satisfying it are made available? The great need is the where-with-all, in other words, the income.

There is a great lack of knowledge in agriculture of just what really constitutes income and an even greater lack of knowledge of those factors that enter into and the part each has to play in securing the final answer.

Income is the difference between the selling price and the cost of production per unit multiplied by the number of units. Let me state it in the form of a mathematical equation. $I = (S-C)\,Q$, where I is income, S is selling price, C is cost of production, and Q is the quantity or number of units.

The industry of agriculture and those who deal with it have accepted the selling price as the answer to the problem, paying little or no attention to either cost of production or the number of units. There is very little knowledge of production costs in agriculture and practically no knowledge of the various factors that go to make up these costs. What meager data is available is in the nature of average figures, conveying no knowledge of maximum efficiencies and in no way connected with the desired thing—income.

Let us analyze cost. Of what is it made up, and what factors influence it, and how?

*An address before the session of the Rural Electric Division at the 21st annual meeting of the American Society of Agricultural Engineers, at University Farm, St. Paul, Minn., June, 1927.

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These expense items are influenced by the yield per acre which are influenced by such items as seed, soil fertility, climate, etc., and by the yield per worker controlled by the size of the operation and by the equipment used. Large operations are only carried on with adequate and efficient equipment, whereas general farm expense per unit is also influenced by the number of units produced with a given equipment. In other words, the dominant factor after a fair standard of efficiency is secured, is quantity. Quantity can far overbalance both yield per acre and efficiency where the operation is small, as compared with a large operation. This is amply proven by comparing the returns from a 5-acre New England operation, where the yield per acre may range from 60 to 80 bu. per acre and the hours for men, horses and equipment run to upwards of 100 hr. per acre, with a corn belt farm where the yield may be only half as great and where the worker produces upwards of 160 acres and with the use of the equipment of less than 10 hr. per acre.

Another group is made up of taxes, maintenance of buildings and fences and such farm property, and can be called farm operating expense. This group is an overhead and should be borne largely by the animal husbandry and manufacturing operations, although some of them are strictly land expenses. No matter where they are charged they are largely fixed and are relatively independent of the kind and size of the crop produced.

Interest on investment is a third group and includes not only interest on mortgages and borrowed money, but also is a return as an investment on a fair value of the land and buildings and the farm-operating equipment. As an operating farm these must be held to a minimum. Many of the excessive costs in agriculture are overhead costs which are the result of high values placed on farm property by speculation and not values that reflect earnings. The term quantity is again a vital factor in holding the cost per unit to a minimum.

Agriculture today is suffering more from costs than from price. It is also suffering from small operating units and inefficient equipment; it is suffering from heavy overhead due to high values that must be borne by a small number of units.

All these factors come within the province of the engineer. Analyzing them and making them understood both to agriculture and to those who are in anyway dependent upon it must be one of the contributions of the agricultural engineer.

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Animal husbandry is not crop farming, although it is an agricultural problem. It follows laws of its own and embraces a wide variation of agricultural functions. Some livestock is raised purely for its food value, another for its ability to produce food or clothing, or both, while another has no accepted food value and produces neither food nor clothing—its function is purely the production of mechanical power.

A detailed analysis should be made to set out clearly the various functions of livestock in agriculture. The laws of its efficiency should be made known and the cost of each product figured. Such an analysis will of necessity introduce a new factor, namely, agricultural manufacturing, with its long list of problems which will vary from ordinary cost-efficiency problems to problems of handling waste products and developing economic markets and new uses, not to mention a long list of such problems as finance, marketing, forecasting market requirements and leadership of the industry which come under the general head of management.

It may seem strange, when one stops to consider, that the agricultural press is largely a part of the machinery of the advertiser to the agricultural market, rather than a part of the machinery of agriculture; or that the county agent is more a government official than an agent under the control and direction of the industry, to which he is supposed to belong; or that the new practices in agriculture should be delegated to the experiment stations or some other tax-supported agent rather than to one controlled by agriculture itself.

Agriculture must assume the direction of its own management on a business, profit-making basis, rather than on a basis of protest against bad practices. It must create machinery of management and direction upon a basis of efficiency, by well-paid workers rather than upon the present basis of some one working for a mere pittance.

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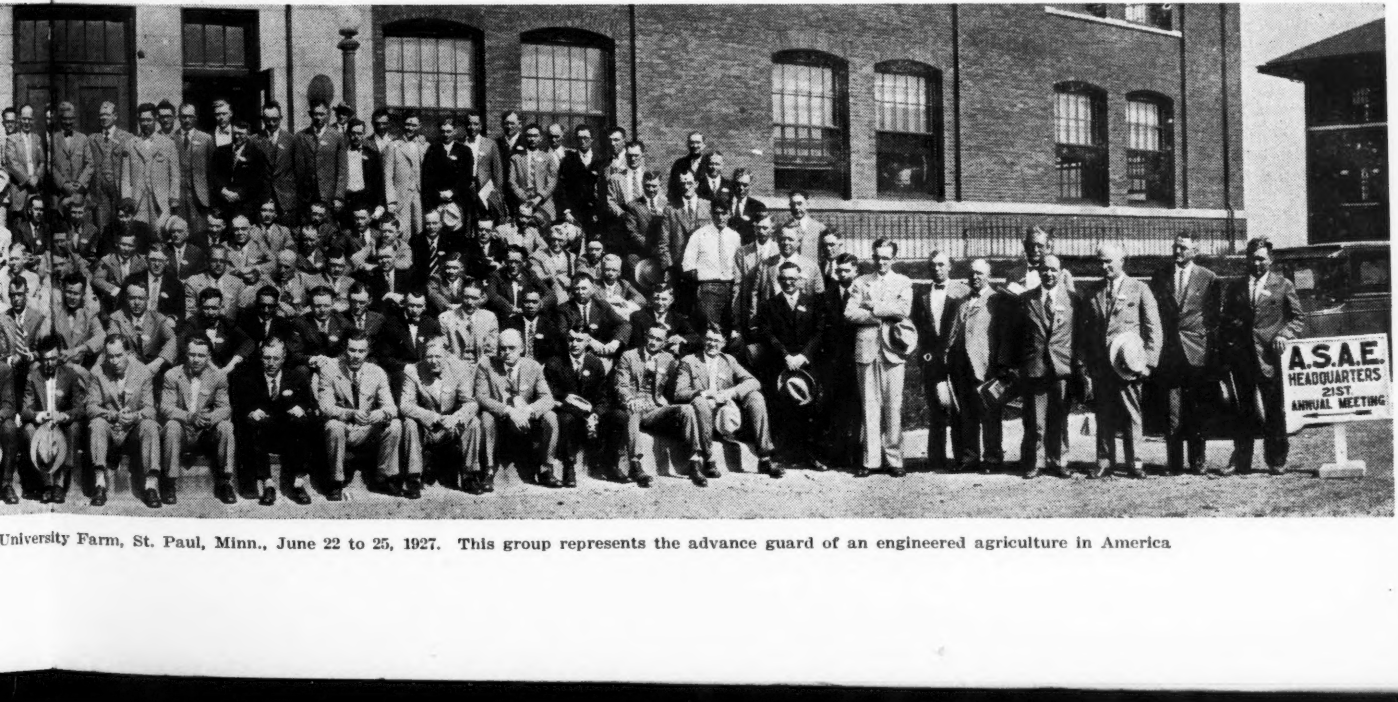

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Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

Research in Agricultural Engineering, 1926*

By R. W. Trullinger[1]

(Continued from the August issue)

STRUCTURES

The work on structures has again dealt with numerous different features of the housing of farm stock and poultry, and with the storage of crops, fruits, and vegetables. Considerable impetus has been given this subject by the activities of the Farm Structures Division of the American Society of Agricultural Engineers. As a result there seemed to be a determined effort during the year, which is apparently being continued, to establish a program of creditable research in farm structures.

Poultry Houses. In studies of the artificial lighting of poultry houses the Ohio station found that electric light is the most efficient, easiest to operate, and best all-round kind of light for poultry houses. One 40-watt bulb should be used for each 200 sq. ft. of floor space, and the lights should not be placed more than 10 ft. apart. The best results were secured by using reflectors to intensify the light on the floor. The reflector should be 16 in. in diameter and cone-shaped, with the cone 4 in. high at the center. For best distribution of light when reflectors are used, the lights should be suspended 6 ft. from the floor, 10 ft. apart, and half way from the front of the dropping board to the front of the house.

In continuing studies of poultry house ventilation and heating, the Nebraska station found that when minimum temperatures of 70, 60, 50, and 40 deg. F. were maintained in four poultry houses, the best egg production for a representative period of two months was obtained from the house in which the minimum temperature was 60 deg. F. Among four other houses one was heated with a stove, one was equipped with electric lights which were switched on automatically at 4:00 a.m., one was tightly closed from 4:00 p.m. to 7:00 a.m. each day, and one was used as a check. Among the eight houses the one with the increased day furnished by electric lights gave the highest production. Using this house as 100 per cent, the house having a minimum temperature of 60 deg. F. stood at 90 per cent and the check unit at 85.9 per cent. The other houses gave poorer results.

The progress results of cooperative studies being conducted by the Iowa station on the air requirements of poultry showed no correlation between air supply and egg production, fertility, or hatchability. While the moisture conditions, especially in the pens receiving the smaller amounts of air, would be considered very bad, the hens appeared contented and maintained egg production equal to those receiving a greater amount of air and slightly greater than similar hens kept on the poultry farm under normal conditions. Much less of the mash fed was consumed in the test pens than under normal conditions.

Studies such as those described above appear to cover considerably more than the field of the agricultural engineer. It would appear more logical for the poultry people to indicate the physiological requirements of poultry for air and heat and for agricultural engineers to confine their efforts to the development of structures to meet these requirements under different climatic conditions. Apparently, however, an exact knowledge of these requirements of poultry is not yet fully available. It is therefore practically necessary for the agricultural engineer to proceed with the establishment of these basic requirements before progress can be made in the development of the corresponding structures. The desirability of doing this in cooperation with the poultry husbandry people seems quite evident, however.

Other more directly engineering studies of poultry houses have been in progress. The Washington station found, for example, that there was practically no difference in the winter, especially during the cold weather, in the temperature and relative humidity in two poultry houses of equal size, one with and one without a straw loft. However, during warm weather the straw loft pen was about 5 deg. cooler than the pen without a straw loft. The moisture content in the litter in the straw loft pen was very heavy. The straw loft averaged about 12 per cent moisture content, and it appeared that this straw did not absorb any moisture from the litter. During the winter months the temperature and relative humidity of open front houses averaged about 5 per cent higher than outside temperatures and humidities, and they were about the same during the summer months.

Silos. Apparently the requirements for strength in silo walls are not yet fully known. Studies by the Montana station to determine the weight of sunflower silage and the lateral pressure it exerts on silo walls showed that, when thoroughly compacted, such silage weighs from one and one-half to three times as much as corn silage. The lateral pressure against silo walls was found to be much greater than it has been assumed to be for corn silage, and for tall silos it is more than twice as great. The conclusion was that the number of hoops or the amount of reinforcing used in building a silo for sunflower silage should be nearly double that used in building a corn silage silo.

Barn Roofs. Apparently there is considerable about the barn roof question which has never yet been settled, and some studies have been in progress. The Michigan station has found that when built on Shawver truss frames, the sprung rafter gothic roof is very rigid, and, since the rafters are supported near their middle, there is much less liability of the roof becoming uneven as compared with the self-supporting frame. It was found, however, that a sprung roof invariably shows some unevenness of its surface due to the practical impossibility of maintaining such a high degree of uniformity in workmanship and material as to prevent minor variations in curvature. Such irregularities apparently do not of necessity indicate structural weakness. With reference to curvature it was found to be good practice to use two-thirds or three-fourths of the width of the barn as the radius of rafter curvature and to locate the center of the arc about 3 ft. below the top of the plate.

These and other investigations seem to indicate that some basic studies of barn roof design are necessary before such structures can be made satisfactory as well as economical. Apparently the requirements which barn roofs must meet are more or less well known. However, it does not seem to be fully established that present designs of barn roofs meet these requirements economically. It seems likely that this is due, in some cases at least, to the fact that the roofs used are partially indeterminate structures.

Building Walls. Studies have been in progress which are resulting in the gradual accumulation of data relating to the structural strength and other properties of walls of different materials suitable for use in farm structures. The U. S. Bureau of Standards, for example, has made studies of the compressive and transverse strengths of hollow tile walls. Tests were made of seventy walls constructed with ordinary workmanship and built under average indoor conditions. The walls were all 6 ft. long, 9 ft. high, and were either 8 or 12 in. thick. The mortar and workmanship seemed to be the most important factors affecting the strength of the end-

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construction walls. Those built with cement lime mortar were about 5.1 times as strong as those built with lime mortar. The mortar had relatively less effect upon the strength of the side-construction walls, those built with cement lime mortar having 2.4 times the strength of those built with lime mortar. There seemed to be no constant ratio between the strength of the walls and the strength of the tiles, but, in general, using the same mortar, this ratio decreased with an increase in tile strength. The maximum loads supported by eccentrically loaded walls were about 60 per cent of the loads supported by similar walls centrally loaded. The transverse strength of the walls was largely affected by differences in mortar and in the position of the tiles. In general the stronger mortars gave higher transverse strengths, and the walls having the tiles laid on the side were stronger under side load than with the tiles on end.

Investigations by private parties of heat losses through plastered and unplastered brick walls have shown that the infiltration loss amounts to from 30 to 40 per cent of the total heat loss through an unplastered brick wall. It was found that plaster either when applied directly on the brick or with furring and lath is very effective in reducing heat loss by infiltration. Paint will reduce infiltration through a plastered wall to a small per cent of its original value.

Fire Protection. The farm fire situation is rather serious in some localities. An investigation of the situation in Pennsylvania by the experiment station and the state fire marshal's office revealed the fact that farm fires are usually traceable to definite causes which may either be removed or nullified by the use of proper measures. In hay barns the seat of the heating and subsequent ignition was found to be under or nearly under the point where the hayfork dropped the hay. As the hay was removed a cone of compressed hay was found which had formed a heat chamber. An almost universal tendency was also found to roll the large bunches of matted hay which dropped from the hayfork to one side instead of tearing them apart and leveling the mow. Temperature measurements indicated that these balls of hay were in themselves small heat chambers. It was necessary to eliminate the matted condition before a loose and well-ventilated mow was possible. Temperature measurements at different points and depths in a mow as it was being filled showed that the heat rose through the cone of compacted hay, and that if the temperature was taken 3 or 4 ft. below the surface and directly at the point where the fork dropped the hay, it was rarely ever more than 5 deg. below the highest temperature registered.

It seems quite evident that information such as the above is desirable before fire protection measures can be taken in the design of structures and in the conduct of storage practices. Where fires are likely to occur it appears probable that isolation measures to prevent spread may sometimes be desirable. Taking everything into consideration it seems desirable to know in advance what to expect in the way of fires so far as possible in order that the structure in question may be designed accordingly. In this connection it may be interesting to draw attention to tests conducted by the U. S. Bureau of Standards sometime ago of the fire resistance of gypsum block partitions. Such block when used in non-bearing partitions not subject to heavy impacts showed good ability to stop or retard fires. The temperatures transmitted to the unexposed side were in no case excessive, and there was no pronounced bulging or cracking. The gypsum on the fire side dehydrated and became weak and crumbly, however. Plaster that remained in place during the fire exposure was found to add considerably to the resistance of the partition, and this indicated the desirability of scoring the surface of the blocks to provide a key for the plaster.

House Heating. In connection with present-day efforts to bring greater comfort and economy in farm dwellings, it may be of interest to note the results of experiments with open fireplaces using all-fire-brick grates to compare the efficiency of ordinary house heating coal with that of dry gas coke from vertical retorts. It was found that the average temperature of the room in which a dry coke was used as fuel was slightly higher than where coal was used, and the average daily consumption of fuel was less by about one-third. The coke gave a radiant fire and no smoke or sulfur fumes. The coke fires began to warm the rooms much more quickly than the coal fires, and the heat radiation was maintained at a high level for prolonged periods. A much greater proportion of the total heat of the combustion of the coke was radiated into the room.

The Influence of Flocculation on the Compression Strength of Gila Clay Loam

(Continued from page 253)

crease in compression strength, although it is well flocculated. The breaking strength of these briquettes when made under 2,000 lbs. pressure (Tests 23-27) exceeds that of the original loam, but when made under low pressures (Tests 58, 59) it does not equal the strength of the original loam. The degree of flocculation in each case is approximately the same. This behavior suggest that the aluminum hydroxide which is formed as a reaction product may add to the binding power of the flocculated colloids.

The briquettes made under conditions somewhat similar to the making of adobe brick or to the drying of wet soil in the field have a much lower breaking strength per gram than the 25 mm. briquettes. This low compression strength results largely from the high percentage of moisture present when the briquettes were made and from the low pressure employed in pressing. These briquettes shrink greatly on drying and tend to develop cracks. The shrinking and cracking is more pronounced because of the larger size of the briquettes (2-in. cubes). This also contributes to a lower breaking strength. The weakness of the loam under these conditions is of advantage agriculturally. In the making of building material it appears best to use a higher briquetting pressure and as low moisture content as possible. The presence of alkali not only weakens the briquette, but it also increases the shrinkage and cracking on drying and the swelling and absorption of water on wetting.

In agricultural lands it appears that the increased breaking strength resulting from deflocculation is in part offset by the tendency to crack and break into blocks, but the poor tilth of such soils and their impermeability to water makes them very undesirable. Soil with these properties is good for lining ditches and reservoirs.

Summary. The compression strength of Gila clay loam with different percentages of moisture and degrees of flocculation was found to vary between 60 and 107 lbs. per gm. for cylindrical briquettes (25 mm. long and 25 mm. in diameter) made under a pressure of 2,000 lbs. per sq. in.; and between 7.8 and 10.6 lbs. per gm. for cubical briquettes (2-in. cubes) made under as low a pressure as possible.

The variation depends on the briquetting pressure, the percentage of moisture present when the briquette is made, the presence of alkali, and the state of flocculation.

The compression strength is greatest when the moisture is sufficient (critical amount) for maximum density. This critical amount is higher for the loams containing sodium compounds, and appears to be less when the loams are deflocculated by leaching; but it is not increased by flocculation with aluminum sulphate.

The compression strength is decreased by the presence of sodium chloride and is increased by the removal of this salt or the carbonate with water, indicating that flocculation decreases the binding power of the colloids. Flocculation with aluminum sulphate, however, does not greatly influence the compression strength.

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Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Irrigation by Overhead Sprinkling, H. A. Wadsworth (California Agricultural Extension Circular 4 (1926), pp. 37, figs. 12).—Working data on the planning and installation of overhead sprinkling irrigation systems for California agriculture are presented, which are based on studies conducted by the California Experiment Station.

It has been found that irrigation by overhead sprinkling is costly and is limited to the production of high priced crops on land of high value. Intensive soil moisture sampling during the irrigation season of 1925 indicated that adequate soil moisture penetration can be secured by the sprinkling of decomposed granite and sandy loam soils if the sprinkling equipment is properly selected and intelligently operated. The evidence with heavy soils is not so conclusive.

Binder and Knotter Troubles, J. M. Smith (Alberta University, College of Agriculture Bulletin 10, 2. ed., rev. (1926), pp. 78, figs. 74).—This is the second revised edition of this bulletin (Agr. Engin., vol. 7, p. 185).

Studies in Rural Electrification (Wisconsin Station Bulletin 388 (1926), pp. 6-11, figs. 4).—The progress results of a series of studies by F. W. Duffee and W. C. Krueger on the application of electricity to different farm practices in Wisconsin are briefly presented.

A study of rates for rural service has indicated that a just rate should consist of a monthly service charge to cover approximately the fixed charges, and a low rate for the current.

In studies of practical equipment, it has been found practical and economical to use electric cooking where cheap fuel is not available on the farm, and electric refrigeration for the household and the dairy. House heating, other than auxiliary small heaters, field work with electric motors, ultra-violet ray treatment for ordinary farm conditions, and heating water for the household have not been found practical or economical.

Water Supply and Sewage Disposal Systems, I. D. Wood (Nebraska Agricultural College Extension Circular 723 (1926), pp. 24, figs. 10).—Practical information on the planning and construction of water supply and sewage disposal systems for farms in Nebraska is presented, together with working drawings and bills of material.

Hog Houses and Equipment, H. P. Twitchell (Ohio Agricultural College Extension Bulletin 57 [1927], pp. 24, figs. 18).—Practical information, working drawings, and bills of material for hog houses and equipment adapted to Ohio conditions are presented.

Farm Building Plans, H. B. White and M. G. Jacobson (Minn. Univ. Agr. Ext. Spec. Bul. 111 (1926), pp. 8, figs. 3).—A list of farm building plans available from the Minnesota Experiment Station is presented.

[Agricultural Engineering Studies at the Wisconsin Station] (Wisconsin Station Bulletin 388 (1926), pp. 11-17, figs. 3).—The progress results of studies on silo filling, cultivating corn with a motor cultivator, harvesting and threshing with the combine, artificial drying of hay, and the drainage of forest lands are briefly presented.

It has been found by F. W. Duffee that flywheel silage cutters of eleven inches or smaller are not economical to operate. In order to get good capacities on such small machines it is usually necessary to operate them at more than the most economical speed, which increases the difficulty of feeding. It seems better to operate a medium sized machine at a lower speed. It has been found that flywheel machines larger than sixteen inches or cylinder machines larger than eighteen or twenty inches are too large to be practical for ordinary use. Reducing the speed of the cylinder or flywheel also reduces the speed of the blower fan.

In the corn cultivating tests by Duffee and J. B. Woods, it was found that the two-row motor cultivator was apparently very practical in fairly small fields and on quite hilly land. The four-row machine apparently would not be satisfactory under such conditions. Equally good, if not better, work was done with both the two-row and four-row cultivators than is commonly done with horses.

The tests of harvesting and threshing with the combine indicated that wheat, rye, barley, and oats can be threshed as soon as cut and the grain safely stored if provision is made for blowing air through the grain. Seven hours of blowing during as many days quite satisfactorily dried the grain and prevented it from heating.

In hay drying tests by Duffee and K. C. MacLeish it was found that two hundred pounds of coal was required to dry out one ton of hay. The results so far obtained are said not to warrant definite recommendations, and the proposition seems rather questionable except possibly under very special conditions.

[Irrigation studies at the Arizona Station], G. E. P. Smith, W. E. Code, and H. C. Schwalen (Arizona Station Report 1923, pp. 488-492).—The progress results of ground water studies, artesian well tests, stream flow measurements, and related subjects are briefly reported.

Sunlight Movable Hog Houses for Kentucky, B. J. Wilford and J. B. Kelley (Kentucky Agricultural College Extension Circular 198 (1926), pp. 22, figs. 14).—Practical information on the planning and construction of sunlight movable hog houses for Kentucky conditions is presented, together with working drawings, bills of material, and a list of hog house plans and equipment.

A.S.T.M. Standards, 1926 (Philadelphia: American Society for Testing Materials, 1926, pp. 102, figs. 15).—This pamphlet comprises the second supplement to the 1924 book of standards of the American Society for Testing Materials and contains sixteen standards for materials used in structures and for metals used in machinery.

[Agricultural Engineering Studies at the Colorado Station] (Colorado Station Report 1926, pp. 41-45).—The progress results of studies by E. B. House of subgrade soils of Colorado, made in cooperation with the U.S.D.A. Bureau of Public Roads, indicate that cracks in concrete pavement are less where there is a longitudinal center joint, where the pavement is thicker at the edges than at the center, and when a dowel is used. Where the grade is low the larger number of cracks are transverse to the center line of the road, and where the grade line is high they are parallel to center line.

In a continuation of the study of humidifying air in buildings, G. A. Cumings found that two humidifiers which operate on the top of radiators and use absorbent material to increase the evaporation surface are of little value in buildings. In no case was the relative humidity of the air raised more than 2 per cent in a room under normal conditions.

Studies on fire protection by carbon dioxide gas by Cumings showed that this gas may be used efficiently and economically to extinguish small fires.

Plans for Concrete Houses (Chicago: Portland Cement Association, 1925, 3. ed., pp. 79, figs. 117).—Plans and general specifications for a large number of concrete houses are presented.

[Agricultural Engineering Studies at the Iowa Station] (Iowa Station Report 1926, pp. 9, 10).—The progress results of studies of the air requirements of poultry conducted by the agricultural engineering section in cooperation with the poultry, chemistry, and veterinary physiology sections are briefly presented. A battery of ten pens of approximately 37.5 square feet of floor space each has been used. Ten birds were placed in each pen and the pens closed. Each pen received a definite amount of air varying by pens from ⅜ to 1½ cubic feet per minute. No correlation could be found between air supply and egg production, fertility, or hatchability. While the moisture conditions, especially in the pens receiving the smaller amounts of air, would be considered very bad, the hens appeared contented and maintained egg production equal to those receiving a greater amount of air and slightly greater than similar hens kept on the poultry farm under normal conditions. Much less of the mash feed was consumed in the test pens than under normal conditions.

Tests of an airplane type of wheel for the generation of electricity by wind power showed that this type of wheel ten feet in diameter gives less power than the ordinary type of wheel fourteen feet in diameter. The airplane type seems much more reliable and less likely to be damaged in wind storms. It was found that the summer months form the questionable period in the output of the plant due to lack of wind.

In an investigation of bituminous concrete, three-inch creosote wood block, cork brick, concrete, rubber blocks, and two-inch homemade wood blocks as dairy barn floor materials, the concrete and rubber blocks showed the least wear.

Sewage Research (New Jersey Stations Report 1925, pp. 45-51).—The progress results of chemical, zoological, and bacteriological studies being conducted on Imhoff tanks are briefly presented. In the zoological studies it was definitely shown that some direct relationship exists between the numbers of protozoa present and the behavior of the tank. Every time the tank foamed the numbers of animals increased enormously. Progress results are also given on the digestion of fresh solids and on the effect of stirring, the addition of fresh solids to ripe sludge, partial sterilization, and chemical precipitation.

Terracing Farm Lands in Texas, (Texas Agricultural College Extension Bulletin B-51 [rev.] (1926), pp. 16, figs. 11).—Practical information on the terracing of farm lands in Texas is presented, which includes descriptions of machines used for the purpose.

The Expansion of Portland Cement Mortar Bars During Disintegration in Sulphate Solutions, T. Thorvaldson, R. K. Lamour, and V. A. Vigfusson (Engineering Journal [Canada], 10 (1927), No. 4, pp. 199-206, fig. 9).—Studies conducted at the University of

Saskatchewan as a further contribution to the deterioration of concrete in alkali soils are reported. A comparison was made between the contraction and expansion of portland cement mortar bars when alternately dried and wetted in water and in sulfate solutions.

It was found that the expansion method for studying sulfate action on concrete has very marked advantages when the action progresses very slowly and the experiments last for months or years.

It was brought out that, although the time of curing is an important factor affecting expansion of mortar bars in sulfate solutions, comparisons of bars cured the same length of time, whether for one week or more, give similar results, and after one month the effect of time of curing is very slight.

Comparisons of the expansion of mortar bars in sulfate solutions were found to be not permissable when the ratio of amount of mortar to amount of solution varies. The effect of richness of mixture on expansion of mortar bars was found to be somewhat greater in the case of solutions of magnesium sulfate than with solutions of sodium sulfate, the difference between the number of days required for equivalent expansion of one to five and one to three bars being greater than in the case of sodium sulfate.

For solutions of both salts the effect of concentration above molar on expansion was found to be almost negligible, and between molar and 0.5 molar very slight. For solutions of lower concentration the effect is more marked and below 0.05 molar the slowing down of the rate of expansion is especially marked in solutions of sodium sulfate. The expansions in saturated solutions of the two salts were found to be nearly identical. The same applies to 0.1 molar solutions. Below this concentration there is a marked difference. For solutions of magnesium sulfate the time required for a given expansion in the most dilute solution used was found to be a little over twice that required to produce the same expansion in a saturated solution. In the case of the corresponding solutions of sodium sulfate the dilute solution requires about five times as much time as a concentrated one for equal expansion. The lower limit of concentration which causes one to five mortar to disintegrate fairly rapidly is commonly found in the seepage water in shallow wells on the central prairie.

With sodium sulfate solutions it was found that each increase of 10 deg. C. (50 deg. F.) in the temperature reduced the time necessary for equivalent expansion by about one-third, with a slight tendency to a decrease in the reduction as the temperature rises. The effect of temperature for solutions of magnesium sulfate between 0 and 22 deg. C. is somewhat greater. There is a marked change in the action of this salt on the mortar, the bars expanding rapidly at first and then more slowly without falling to pieces until finally those kept at 0.5 deg. C. show a greater expansion than those kept at 40 deg. C.

The percentage of mixing water used was found to have a very marked effect on the expansion of mortars in sulfate solutions.

Principles of Final Soil Classification, C. Terzaghi (U. S. Department of Agriculture, Public Roads, 8 (1927), No. 3, pp. 41-53, fig. 15).—In a contribution from the Massachusetts Institute of Technology, the principles of final soil classification for use in the design of engineering structures are presented on the basis of a large number of studies. The data on which it is proposed that the final soil classifications be based give information about (1) the volume change produced by a change of the external pressure which acts on the soil, (2) the speed with which the volume change follows a change of the pressure, (3) the permeability of the soil, (4) the volume change due to drying and wetting under standard conditions, and (5) the consistency of the soil in two extreme states. The conclusion is drawn that the investigations concerning the colloidal character of soil constituents, dye adsorption, base exhange, and the like fall in the same class as investigations concerning the effect of the carbon content and of various alloys on the strength of steel or as analyses of the physical and chemical action in cement during the process of setting.

Comparison of Gasolines by Analytical and Engine Tests, D. R. Stevens and S. P. Maeley (Industrial and Engineering Chemistry, 19 (1927), No. 2, pp. 226-231, fig. 1).—Studies conducted at the Mellon Institute of Industrial Research are reported in which eighteen gasolines composed entirely of petroleum were analysed for their content of paraffins, naphthenes, aromatics, and unsaturated hydrocarbons. The same gasolines were then tested for detonating tendency by engine tests, using a direct-reading detonation indicator. A comparison of the benzine equivalents calculated from analysis with those determined by engine tests showed that the agreement was moderately fair for about half the fuels studied, but that rather wide discrepancies occurred in the other cases.

It is concluded that the antiknock values of gasolines can not be satisfactorily determined by this method. Using pure hydrocarbons an equivalence in knock reduction of approximately 2 : 2 : 1 was found for a naphthene, an olefin, and an aromatic hydrocarbon, as represented by methylcyclohexane, hexylene, and toluene. Qualitative evidence was also found that there are striking differences in the detonating tendencies of the paraffin hydrocarbons present in different gasolines. Normal heptaine was found to knock harder than petroleum paraffins, and this may indicate the desirability of branched-chain paraffins as motor fuels.

Experimental Determinations of Static and Impact Loads Transmitted to Culverts, M. G. Spangler, C. Mason, and R. Winfrey (Iowa Engineering Experiment Station Bulletin 79 (1926), pp. 80, figs. 48).—Studies are reported, the results of which are taken to indicate that culverts should be designed to carry loads equal to the dead leads upon them from the embankment materials plus from 150 to 200 per cent of $\frac{C_tT}{1}$ to allow for the effect of moving concentrated traffic loads. C_t is the coefficient of transmitted load, T is the total concentrated load applied at one point on the surface of the embankment, and 1 is the length of the test section of culvert. It was found that the actual impact blows reaching the culvert tops vary greatly with accidental conditions accompanying the exigencies of actual traffic, weather, and soil conditions. The above allowances are believed to safely provide for the impact effects which are reasonably expected to occur occasionally, at least for trucks running at speeds up to 10 mi. per hour. As with static superloads, the effects of moving superloads are negligible for heights of embankment exceeding 5 ft. for culverts up to 3.5 ft. in width and above moderate heights for wider culverts.

With reference to static loads, the formula $W_t = \frac{C_tT}{1}$ should be used in designing culverts or conduits through embankments when it is necessary to design for superimposed concentrated loads of a static nature. In this formula W_t is the total corresponding load, per unit of length, transmitted to the top area of the test section. For sizes of culverts up to 3.5 ft. in width, the loads on culverts from concentrated static loads at the surface are negligible in proportion to loads from embankment materials for depths of embankment greater than 5 ft. For culverts wider than 3.5 ft. the depth at which the effect of concentrated loads may be neglected is greater than 5 ft., but will be moderate.

Concrete Cradles for Large Pipe Conduits, W. J. Schlick and J. W. Johnson (Iowa Engineering Station Bulletin 80 (1926), p. 43, fig. 18).—Studies are reported which show that the supporting strength of pipe before cracking may be increased from 50 to 100 per cent by the use of properly designed cradles. The percentage of increase with a particular cradle will vary with the quality of the pipe and is higher for the weaker and lower for the stronger pipe. The use of a cradle which has thickness under the pipe of one-fourth the nominal diameter of the pipe and which extends up the sides to a height of one-fourth the outside diameter of the pipe should increase the supporting strength about 75 per cent. Decreasing the proportional thickness of the cradle under the pipe and its height at the sides each reduced the effectiveness of the cradle. It is considered doubtful if it will be economically advisable to use reenforcing in a cradle with a thickness less than one-fourth the diameter under the pipe and a height at the sides of less than one-half the diameter for small pipe or one-third the diameter for large pipe. Reenforcing appears to be of value only in that portion of the cradle under the pipe. None of the cradles tested developed a visible fracture or crack except under the pipe. Properly designed and constructed reenforced cradles of these dimensions should increase the cracking strength of the pipe from 75 to 100 per cent. Because of the lack of opportunity to develop side support as the pipe deformed after cracking, the ultimate loads sustained by cradled pipe in the tests were considered as measures of only the minimum ultimates which similarly cradled pipe would develop in actual installations. It is concluded that if the effectiveness of cradles for reenforced concrete pipe are to be based upon the supporting strength of the pipe before developing a crack of a specified surface width, consideration should be given to the higher supporting strength of the pipe itself at this cracking load and to the side support that may be developed through the deformation of the pipe and the cradle. This side support may be material in the case of pipe in trenches in firm soil.

Run-off From Small Agricultural Areas, C. E. Ramser (Journal of Agricultural Research [U. S.], 34 (1927), No. 9, pp. 797-823, fig. 15).—In a contribution from the U.S.D.A. Bureau of Public Roads data from measurements of rainfall on and run-off from six small agricultural watersheds of silt loam soil, ranging in area from 1.25 to 112 acres, are reported.

The results show conclusively that timber has a decided influence in reducing the rate of run-off from a watershed. However, this influence appears to be slight when the maximum rate of run-off occurs after considerable rain already has fallen. This is attributed to the fact that interception and percolation on timbered areas are much greater at the beginning of a rain than later, so that an increasingly greater proportion of the rainfall runs off as the rain continues.

A comparative study of the rates of rainfall and run-off for different storms showed apparently unaccountable variations in the run-off coefficients. "There are many interdependent factors entering into the relation between rainfall and run-off and it is practically impossible to evaluate all of them accurately. For instance, the effect of previous rains upon the capacity of the ground to absorb water from subsequent rains depends upon the nature and amount of previous rainfall, the interval of time between rains, and the amount of water lost through transpiration and evaporation during this interval. If the maximum rate of rainfall occurs at the beginning of the rain, before the surface of the ground has been thoroughly wetted, the percentage of run-off is less than when the maximum rate occurs some time after the beginning of the rain. A greater percentage of run-off also occurs for heavy than for light rains. . . . Non-uniformity in the rates of rainfall during the time of concentration is responsible for considerable variation in the run-off coefficient for the same watershed."

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RAYMOND OLNEY, Editor

"By Their Fruits—"

A GROUP of agricultural engineers—the president, first vice-president, and three past-presidents of the society of which this journal is the official organ—recently had an audience with the President of the United States on matters pertaining to the agricultural industry in which the agricultural-engineering profession is particularly interested. So far as recognition in influential official circles is concerned, certainly the top rung of the ladder has been reached. Elsewhere in this issue is reported the substance of the presentation, together with recommendations, made by the group representing this Society to President Coolidge.

Everything considered, this interview may be said to be a very much worth while achievement for the profession the Society represents. It is particularly an achievement as viewed from the standpoint of our having gained a larger public recognition of the service which agricultural engineers are in position to render the agricultural industry and the country at large.

No one who has followed the work of agricultural engineers during recent years, particularly as reflected in the activities and accomplishments of the society representing them, will dispute the fact that such recognition in the highest circles is merited.

Agricultural development has made splendid progress in almost all phases. In the particular phase in which we are interested—that of engineering—development, however, has been extremely slow. But agricultural engineers are rapidly changing that situation, and the interview which they were recently successful in obtaining with the President of the United States is evidence, not only that they have made good progress, but also that their importance and place in agricultural development is being substantially recognized.

During the past year and a half the agricultural-engineering profession has received more recognition than in all its previous history perhaps. But at this time let it not be forgotten that the more recognition we receive, the more our responsibility increases. Certainly our responsibilities have increased many fold. We are not afraid of whatever responsibilities we may be asked to accept, but, as a word of caution, it is well to understand that the important thing now is to shoulder them promptly, vigorously, intelligently—as has ever been characteristic of our profession—for, in the final analysis, "by their fruits ye shall know them."

"Agricultural Engineers"

[The New York Times]

THIS is an association which for the first time figures among those giving advice to President Coolidge in farming matters. We have had all kinds of volunteer authorities on agriculture, along with societies that took a little interest in the land but a great deal more in politics, so that it is a refreshing novelty to hear such words of truth and soberness as the agricultural engineers spoke to the President. They deal with the farm problem just as if it were an ordinary business one. Higher efficiency must be sought. Increased production per worker must be secured. The cost of production must be lowered by better methods of operation and better management. Turning to the question of credit for agriculture, the agricultural engineers declare that "greater emphasis should be placed on earnings than on estimated or speculative land values." This will seem particularly horrifying to farmers who paid too much for their holdings in a "boom" time, and now expect the banks to lend to them on an inflated value.

Let it not be thought that the agricultural engineers are a cold-blooded lot without sympathy for the farmer or understanding of his peculiar needs. They have carefully studied the various projects for farm relief. Some of them they approve. But they do this guardedly, and not as men who expect an agricultural millennium to be brought in overnight by any bill that congress may enact into law. Plans for orderly and well-financed cooperative marketing they endorse, and believe that they will work well under proper supervision. But for the ordinary farming cure-alls, especially those colored by politics, they have no use at all. Their visit to the President, it may be hoped, marks the beginning of saner and sounder discussions of the whole vexed question.

EDITOR'S NOTE: The foregoing editorial appeared originally in the New York "Times;" it was copied by the Chicago "Tribune." We don't know how many other papers copied it. It is both inspiring and gratifying when leading newspapers of the land give such evidence of having a true appreciation of the motives and efforts of agricultural engineers.

How We Can Serve Best

MOST problems with which agricultural engineers are confronted involve other phases of agricultural science. In other words, before the agricultural engineer is in position to attack a particular problem, certain fundamental requirements outside the field of engineering may have to be known, and with which the agricultural engineer is not familiar. It may be necessary for the agronomist, the entomologist, or other agricultural scientist to set up these fundamental requirements in order that the agricultural engineer may intelligently approach his phase of the problem. The reports of the Research Committee of the Society are more and more pointing out cases of cooperative research projects at the agricultural experiment stations where agricultural engineers are working closely with other agricultural scientists on common problems.

There is so much of this in connection with agricultural problems, that it is highly important for agricultural engineers to develop the cooperative attitude in all their work. In the past certain agricultural scientists have been reluctant to admit that engineering was an important factor in the problems with which they were confronted. Be that as it may, the agricultural engineer will find it to his best interests to seek the cooperation of different groups of scientists concerned with the problems before him and give them credit where credit is due. This attitude will do more to advance the interests of the agricultural engineer than almost anything else he could do. In the main, it may be said that this is the general attitude which exists now among agricultural engineers. It is best that we encourage it in every possible way. Moreover, this attitude is the answer to the question as to how we can serve best.

A. S. A. E. and Related Activities

A.S.A.E. Representatives Interview President Coolidge

ON AUGUST 30 representatives of the American Society of Agricultural Engineers met with President Coolidge at the summer White House at Rapid City, South Dakota, for the purpose of acquainting him with the viewpoint of the agricultural engineers on the present agricultural situation and farm problems in general, and also to present recommendations, which, quoting from the report, "will, in our judgment, contribute to the betterment of American agriculture." The Society representatives to interview President Coolidge were President O. B. Zimmerman, First Vice-President Arthur Huntington, and Past-presidents J. B. Davidson, O. W. Sjogren, and F. A. Wirt.

In their memorandum to the President the Society representatives outlined the relation of engineering to agricultural development from the days of the Revolution, placing the year 1850 as the high point in progress, as it ended the period of hand-method farming. Coming to the present situation and attendant problems the statement read:

"Viewed nationally, there are four essential factors involved in agricultural production: the quantity of agricultural products produced, the quality of the products, the costs of the products to the consumer, and the well-being of those engaged in the agricultural industry.

"The present problem in agriculture is to be found in the fourth factor, the well-being of those engaged in the industry, because the quantity of products is adequate, the quality of the products is satisfactory and the cost of food and other agricultural products to the consumer is not excessive. A large number of American farmers do not enjoy as favorable a situation as the individuals in other industries and vocations.

"We believe that the solution of the problem of improving the well-being of the rural resident or raising the standard of living in rural life, depends upon the development of a general desire for better living on the part of those engaged in the industry and upon an increase in the income of the farm worker.

"The development of a general desire for a better standard of living is largely a matter of education. The income of the farm worker depends upon many factors. At the present time much emphasis is placed upon the relation of price to income. An increase in price with a corresponding increase in cost, due to increased land values, does not result in any increased income, and therefore we believe the interest of the land speculator to be opposed to the best interests of the farmer.

The group of A.S.A.E. members that interviewed President Coolidge. Seated, President O. B. Zimmerman. Standing, left to right, Past-Presidents J. B. Davidson, F. A. Wirt and O. W. Sjogren, and First Vice-President Arthur Huntington

"Labor and power are large items in the cost of production, varying from 40 to 85 per cent of the cost of producing field crops and offers the most inviting opportunity to increase income through efficiency and increased production of the agricultural worker. It is through the efficiency of the use of these factors of production that the American farmer now maintains an enviable position compared with the farmers of other countries. It is through further advance in efficiency that he may be expected to advance to a more desirable situation. It is recognized that greater efficiency in the use of labor and power does not conflict with an advance in better crop practice.

"We could show that many agricultural workers through the efficient use of power and equipment are producing as much per worker as the industrial producer, and these people are prosperous; that there are those of another class who are just about breaking even, and another class which is hopelessly lost. The latter group only produce at a high cost but live on a very low standard.

"You may more fully appreciate the disparity between agriculture and industry when we tell you that one authority states that it takes the average agricultural worker 2.18 hours to produce that which will exchange in the market for that which the city industrial produces in an hour. The cost of producing wheat varies from about $3.00 per acre to more than $7.00 per acre. The cost of producing pork varies from 5 cents per pound to more than 20 cents, and butter varies from 20 cents to more than 60 cents. The two vital factors in the agricultural depression are in the inefficient farmer and the lack of equipment efficiently used. Machinery, power, and proper engineering direction are vital factors in making an agricultural worker the equal of the industrial producer."

The report concluded with the following definite recommendation:

"1. We solicit interest in the consideration of all of the factors which determine the farm workers' income and that due regard be given to the securing of increased production per farm worker and the lowering of the cost of production by the adoption of more efficient methods of operation and management. This recommendation in no way minimizes any sound, business-like method of increasing the selling prices of farm products or the orderly marketing of the same. It is further requested that, in the compiling of agricultural statistics and data, major importance be given to results obtained by the best rather than to average results.

"2. That in the financing of agriculture greater emphasis be placed on earnings than on estimated or speculative land values.

"3. That encouragement be given to the further development of industrial uses of all farm products.

"4. That support be given to a study of the problem of the transfer of surplus farm population to industrial activities.

"5. That endorsement be given to an engineering study to be made of the losses in agriculture in cooperation with the American Engineering Council and the American Society of Agricultural Engineers with the objective of securing greater production per worker and lowering the cost of production.

"6. That in the organization of flood control measures, due consideration be given to the importance of retarding flood waters in the upper reaches of the drainage areas, particularly by methods now practiced by agricultural engineers.

"7. That encouragement be given to the development of an enlarged research program to support and supplement the work now so ably being conducted by the state colleges, by experiment stations and by the various federal agencies in the solution of agricultural problems and in recommending the adoption of better farm practices.

"8. That favorable consideration be given to the request for the change of the status of the present division of agricultural engineering of the bureau of public roads in the U. S. Department of Agriculture, to that of a bureau of agricultural engineering in the U. S. Department of Agriculture."

North Atlantic Section Meets at Pittsburgh

AT ITS third meeting, to be held October 19 to 21, inclusive, at East Pittsburgh, Pennsylvania, the North Atlantic Section of the American Society of Agricultural Engineers will be the guests of the Westinghouse Electric & Manufacturing Company.

According to a tentative program the first session will open Wednesday afternoon, October 19, with the Annual Address of the chairman, C. I. Gunness, and a welcome to Pittsburgh by some prominent local man. Addresses and discussions at the various sessions will cover the following subjects: Rural Electrification in Ontario, by J. W. Purcell; A Season with the Corn Borer Campaign, by A. M. Goodman; Ways and Means of Reducing the Cost of Farm Produce; Painting of Farm Buildings, by R. E. Rogers; The Control of the Strength of Concrete, by W. G. Kaiser; Review of Accomplishments in Rural Electrification, by E. A. White; Fruit and Vegetable Storage; Economics of Farm Structures and Equipment; Use of Explosives in Agriculture, by F. T. Ransom; Characteristics of Motors, by W. D. Hemker. Col. O. B. Zimmerman, president of the American Society of Agricultural Engineers, will also appear on the program.

Rural electrification has become such an important phase of agricultural engineering that it has demanded special sessions which will be held simultaneously with the general sessions. The number of such sessions to be held is not yet decided. It is an interesting and perhaps significant observation that leaders of this new and flourishing development take every opportunity to meet and discuss their problems.

In addition to the technical sessions there will be inspection trips through a steel mill, through the Heinz factory and through the Westinghouse plant. The business meeting and the banquet of the North Atlantic Section will be held on Friday evening, October 21.

More than twenty-five different addresses and events will be included in the three-day program. A great deal of interest has been shown in the meeting and a record attendance is expected.

The meeting headquarters will be at Webster Hall in Pittsburgh. All of the various sessions will be held there, excepting those scheduled for Friday morning and afternoon. These sessions will be held at the plant of Westinghouse Electric and Manufacturing Company in East Pittsburgh. As Webster Hall is a bachelor hotel, arrangements have been made with the Schenley Hotel two blocks away to accommodate those who bring their wives. Those who come by train are advised to get off at Pittsburgh rather than at East Pittsburgh. More detailed information in regard to the meeting will be available in the near future.

Machinery and Structures Meetings

THE programs for the two-day meetings of the Power and Machinery Division and the Structures Division of the American Society of Agricultural Engineers, to be held at Hotel Sherman, Chicago, November 29 and 30, and December 1 and 2, respectively, have been outlined and arrangements with speakers are now being made.

The program of the Machinery Division will provide for a half-day session on the combine, which will be divided into two sections, namely, state and federal reports on 1927 combine investigations and recent developments in the combine.

The major portion of a one-half day session will be devoted to the subject of crop drying, including both hay and grain. The progress of the national program of research in mechanical farm equipment will also be a feature of this session.

Recent developments in tillage and tillage machinery will feature a third half-day's session. This will include the cylinder disk plow, duck-foot harrow, rotary hoe, etc. The subject of mole drainage will also be presented at this session.

A fourth half-day's session will feature recent changes in tractors as noted from the Nebraska tractor tests, supplemented by discussions by engineers in the tractor industry on recent developments in tractor design. A part of this session will be devoted to discussions of progress in the control of the European corn borer.

Another feature of the meeting will be the showing of motion pictures between 5:00 and 6:00 P.M. each day, of recent developments in farm machinery.

The meeting of the Structures Division, on December 1 and 2, will open with a half-day's session devoted to farm homes, featuring those problems in which agricultural engineers are particularly interested.

The afternoon session of the first day's program will feature a paper, entitled "The Determination of Basic Requirements for Farm Structures," by M. C. Betts, architect, U.S.D.A Division of Agricultural Engineering. This will be followed by a symposium, entitled "Opportunities for Research in Farm Structures," to which prominent agricultural engineers will contribute. An effort is also being made to secure one or more directors of agricultural experiment stations to participate in the discussion of the subject.

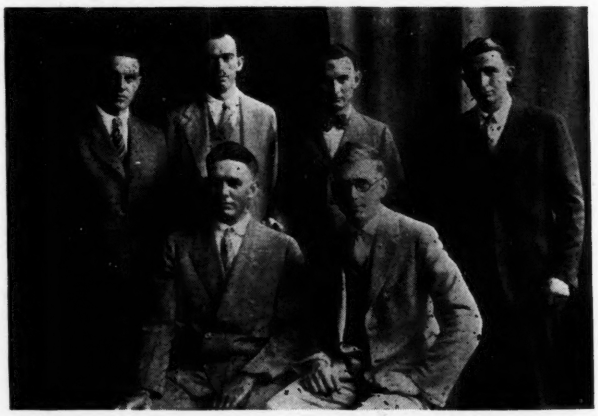
The subject which will feature the forenoon session of the second day is how much money can be invested in farm structures on the basis of the production that may be expected. The discussion of this subject will be opened by the presentation of a paper by J. L. Strahan, agricultural engineer, Louden Machinery Company. The session will also feature a paper on the subject of cutting labor and production costs by the efficient planning of farm buildings by an Ohio farmer who has had exceptional success in this direction.

The last half-day's session will be devoted largely to a general discussion of farm building problems with which the Structures Division is concerned, and a special effort will be made to formulate a definite program of organized attack on these problems, including specifically a program for the Structures Division.

Rural Electric Training Course Established

BELIEVING that rural electrification will progress most rapidly under the direction of men born and raised on the farm and with an agricultural engineering education, the General Electric Company has undertaken to give such men the supplementary training in electricity which is essential to the rural electric specialist.

Five students have been picked from widely separated parts of the country and have been given a special instructor under the supervision of the sales training department of the company. Eight months will be required for the completion of the course. The first ten weeks will be spent at



The first class in the General Electric Company's new electrification training course. Seated, left to right, Maxwell Greenler, Holgate, Ohio; Alfred J. Van Scholck, Cochocton Center, New York. Standing, left to right, Ralph Piper, Sharon, Wisconsin; J. F. Hixton, Banks, Alabama; Eugene N. Gatlin, Dallas, Texas; G. A. Rietz, Salem, South Dakota. Mr. Rietz is the instructor of the class